New Land Under Irrigation

A Thesis

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By

Walter William Stokesberry, B.S. (Agr)

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NEW LAND UNDER IRRIGATION.

Irrigation is the foundation of truly scientific Agriculture.? Tilling the soil by dependence upon the rainfall is by comparison like the old stage coach to the modern means of travel.? The perfect conditions for scientific agriculture would be presented by a place where it never rained, but where a system of irrigation furnished a never failing water supply, which could be adjusted to the varying needs of different plants.? It is difficult for those who have been in the habit of thinking of irrigation as merely a substitute for rain; to grasp the truth that precisely the contrary is the case. Rain is the poor dependence of those who cannot obtain the advantage of irrigation.?

The supreme advantage of irrigation consists,-not more in the fact that it assures moisture regardless of the weather, than in the fact that it makes it possible to apply, that moisture just when and just where it is needed. For instance, on some cloudless day the alfalfa field looks thirsty, and crys for water through the unmistakable language of its leaves. In the Atlantic states it probably would not rain, at the exact moment, such is the preversity of nature, and if it did the rain falling upon the just and the unjust, would satisfy the every need of the alfalfa plant, while on the other hand the tiny cells of the sugar beet, the purpose of which is the production of saccarouse, are made to grow woody and pithy;

thus the farmer holds in hand the power to place water where it is needed and guide nature to its utmost.

In choosing a farm which is to be irrigated, one should be guided to some extent by the climatic conditions and the crops which can be profitably grown, preference being given to a locality having cool summers coupled with short winters of frost and snow.

In choosing land which is to be irrigated, one should make a careful examination as to the character and depth of the soil, its behavior when irrigated, the slope and evenness of the surface, the presence of injurious salts, and the facilities for drainage. One of the best indications of the character of the soil is the native vegetation which grows upon it. When sage-brush is found on a tract, it is reasonably certain that the soil is fertile, easily tilled and well drained. On the other hand, greasewood or salt-grass is an indication for a heavy soil, which is not easily cultivated, and which contains more or less of the injurious salts, usually grouped under the common name of alkali.

Soil is made up of very fine particles of irregular shapes. It is formed by the breaking down of rocks of different compositions, which are disintegrated by the weather, ground up and distributed by physical action and floods, and mixed with the products of successive ages of vegetable growth.

As the soil particles cannot lie together so as to form a solid mass, - there is a large amount of intervening space, which in an average soil equals nearly half its volume. The smaller the particles the greater the pore space. Thus, clay soil contains 65% pore space, while a sandy soil contains something like 25%, and all others varying between these extremes.

Soils of intermediate fineness lend themselves most readily to the practice of irrigation. Excessive heavy clay is generally to be avoided, because of (a) the slow diffusion of water, by both capilarity and percolation, and (b) the danger from puddling after an irrigation. On the other hand, very light sand should be avoided because of its leaching, and the loss of water and plant food by percolation or evaporation.

Organic matter in the form of Humus, has a greater capacity for moisture than has the mineral portion of the soil. No definite statement can be made as to the water holding capacity of Humus, as the moisture content of such material varies with the stage of decay.

Organic matter effects the moisture capacity through its influence on soil structure. In a clay, by the addition of humus, a granulation is produced, which increases the moisture capacity. And, its addition to sand has a similar, though smaller effect.

Therefore, as the demand for produce of higher value increases, the maintainance of the moisture supply of the soil by irrigation must be extended. To attain the best results under irrigation, the water capacity of a soil must be increased, that is, the loses by percolation and evaporation must be taken into consideration, Also the danger of the rise of alkali is increased by the application of too much water. Consequently, these deficiencies may be regulated by applying the proper amount of organic matter and cultivation.

Easily irrigated soil will absorb sufficient water in

24 hours after an irrigation to become moist to a depth of two or three feet. Some soils are so impervious that it is impossible to wet more than a few inches below the surface, while others are so porous that the water soon percolates through beyond the reach of the roots.

Soil moisture is subject to movement in three ways,- -a- gravitational, -b- Capillary, and -c- Thermal.

Gravitational movement is the result of the gravity pull upon the soil water. The slower the downward movement of water, the longer the water will be in the root zone of a crop, and therefore the greater use will the plant be able to make of that particular supply of moisture. It was said above, that gravitational water was that part of the soil water which is free to move under the influence of gravity. Such movement constitutes percolation.

The rate of percolation consists of two conditions; -a- the texture of the soil, -b- and structure of the soil. The rate of movement depends upon the diameter of the individual soil particles, that is the larger the pore space, the more freely will the water descend.

Under field conditions the percolation through the soil is facilitated by the presence of numerous cracks, root passages, and insect burrows, because of their relatively large diameter.

The soil is filled with a great quantity of air. The entrance of irrigation water into the dry soil where it is applied in sheets over the surface is hindered by the presence of the air in the pores in the soil. Therefore, if the soil is in a very loose condition to the depth of 10 or 12 inches the water will percolate rapidly, and a larger part will find its way into the deep sub-soil to be permanently retained, which would not be so if the surface soil were not uniformly fine.

Capillary water it the water occurring in the soil in a thin film overspreading the particles, and thickened in a waiste-like form at their point of contact. In a soil capillary saturated with water there is no movement, for the pull at any one point is balanced by the pull from every other point, which is due to the surface curvature of the film and to the density of the liquid. Capillary movement of water is of great consequence to growing plants, as it effects that form of soil water upon which ordinary crops are directly dependent.

In a fine soil there will be more surface exposed, which will give more points of contact between the particles, consequently the greater the capillary power the surer the movement. Water moves through the soil in the form of a thin sheet-like film, consequently the movement is determined by the size of the individual particles and by the amount of pore space involved. Therefore, the dry fine textured soil will retain moisture as vapor more effectively than does a coarse textured soil. According to capilarity it is necessary that the soil be of intermediate fineness for the practice of irrigation.

The intending farmer should likewise keep in mind the nature of the ground surface which has a uniform slope of ten to twenty feet to the mile. Such land costs little to put into shape for the spreading of water over it, and the slope insures good drainage. On the other extreme one finds land full of Buffalo and Hog wallows. These alternating heights and hollows are difficult to reduce to an even grade. Again, the land may be cut up by ravines, thereby increasing the labor and cost of putting water upon it, or it may have too much or too little slope. If land which is naturally smooth on the surface and of the right slope costs approximately six dollars per acre to put into shape for irrigation, hog-wallows may cost from two to fourteen times as much. Thus it is evident that the cost of preparing the surface is an important consideration in the first cost of the land, besides, hog-wallow land is inferior in quality, being frequently changed with injurious salts.

It is essential for the permanently productive irrigated farm to have a good drainage, as it is impossible to supply crops with sufficient water, without applying so much that some will seep into the sub-soil. Unless this is able to flow away the level of the ground water will be brought near the surface, where it will cause an accumulation of alkali and will drown out the crops. If land has not a good natural drainage it should be supplied artificially before many crops have been raised.

Thewater right for irrigation is usually about one third the value of the land. Water rights usually sell below their value to the farmer, because of the uncertainty regarding titles. In many cases the water right has never been defined or established, therefore an examination should be made before purchasing such rights.

Water for a farm must be obtained from the unappropriated waters of a natural stream, from a canal company which has water to sell, or from one of the Government irrigation projects. But, one of the best methods is a co-operative or mutual water company, in which the owners of the land to be irrigated become the owners of the stock in the water company. In diverting water from a stream, the state engineer should be consulted, as he has charge of the appropriation, and diversion of water which flows in any stream.

The most common source of the water supply for the new settlers is from one of the Government irrigation projects, Under this system the water is furnished to the land through a water users association, in which all of the land owners within the project become share-holders in the association. The cost of the water right under the Government varies from about $15.00 to $40.00 per acre, being paid in ten equal annual installments, and failure to make any two payments when due may forfeit the right. When the payments for the water for the major portion of the land under any project have been made, the operation and management of the irrigation system passes to the owners of the land irrigated, to be maintained and operated at their expense. The cost will then be a pro-rate share of the actual operating expenses.

Whatever the source of supply, a network of ditches to carry the water over the farm is necessary. The capacity of the ditches depend upon the manner of delivering the water and the method used in applying. It also depends upon the size of the farm, the nature of the soil, and the crop raised. But, for the average farm the supply ditches are accordingly small, carrying from 40 to 70 miner's inches, or two cubic feet per second.

In the construction of ditches the form depends largely upon the implements used in making the excavations, but the method used is to run a plow two to three times along the course of the ditch, and then shovel the loose dirt out, forming an embankment on each side.

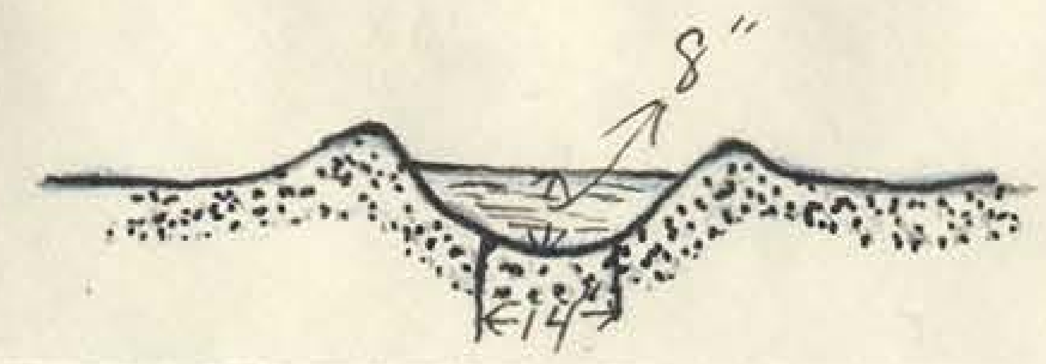

fig. 1.

Figure one represents the cross-section of a ditch made with a 14" plow, which was cleaned out with a shovel. This will carry from thirty to sixty miner's inches of water.

On a farm the grade of the ditch should not exceed that of the land. On rolling land, where there are steep slopes, a suitable grade can usually be found by running them across the slope rather than directly down them.

Farm ditches should be located in the right place at the start. It is a mistake if they are built for the lower part of the farm first, and then later on, when there is a desire to irrigate the remainder, it would be necessary to build other ditches for the higher land. Water should first be conveyed to the highest point, and from ther distributed to the various sub-divisions. In laying out the permanent ditches and effort should be made to locate them along fence borders, as they obstruct the passage of implements and teams in the field. It often happens that a farm is more or less cut up by ravines or deep depressions. In case the supply ditch must cross this, the best method where possible is to build a levee, this may cause trouble for the first two seasons, because it is subject to leaks and washouts, but it is the cheapest.

The banks of supply ditches should be graded and smoothed, every season, so that the weeds will not grow, as the weed seed is widely distributed by irrigation streams.

In laying out the supply ditches an engineer's level and rod are the most convenient instruments to be used.

A headgate to control the flow from the main canal or lateral to the private ditch is needed. The canal corporation for their own interests demand that the gate shall be water-tight when closed, and large enough to admit the necessary flow of water, and so made that it cannot be raised above a certain height. The head-gate is placed at the edge of the canal and either a wooden box or pipe conveys the water under the embankment of the canal. A convenient type of head-gate is shown in figure 2.

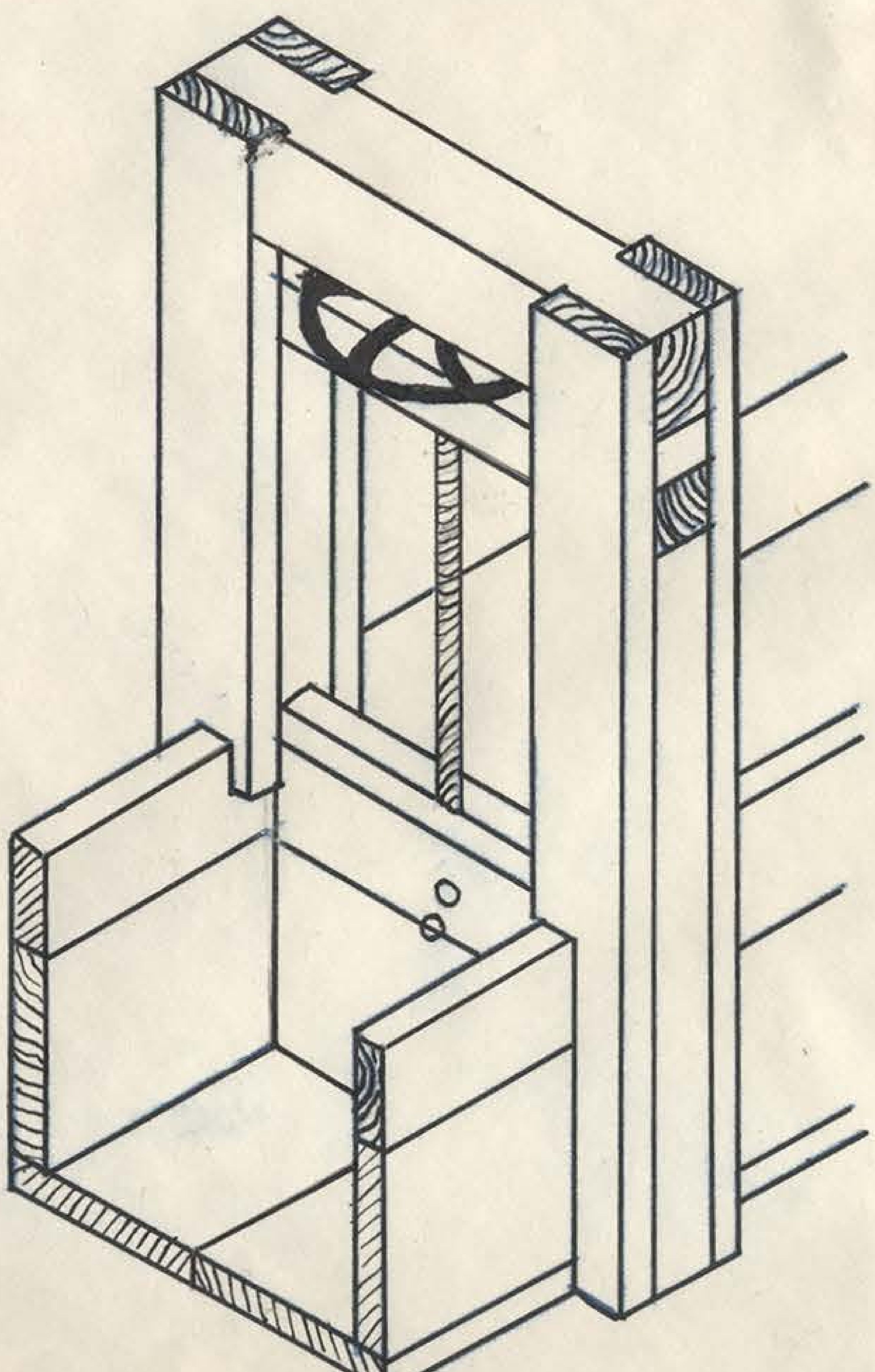

fig.2. lateral head-gate.

Irrigation water is measured when it is delivered to the farmer. A very common device is the Weir, which consists of a box or flume 12 feet long and over 5 feet wide.. 8 feet from the upper end a Weir board is inserted of the form and dimensions shown in figure 3.

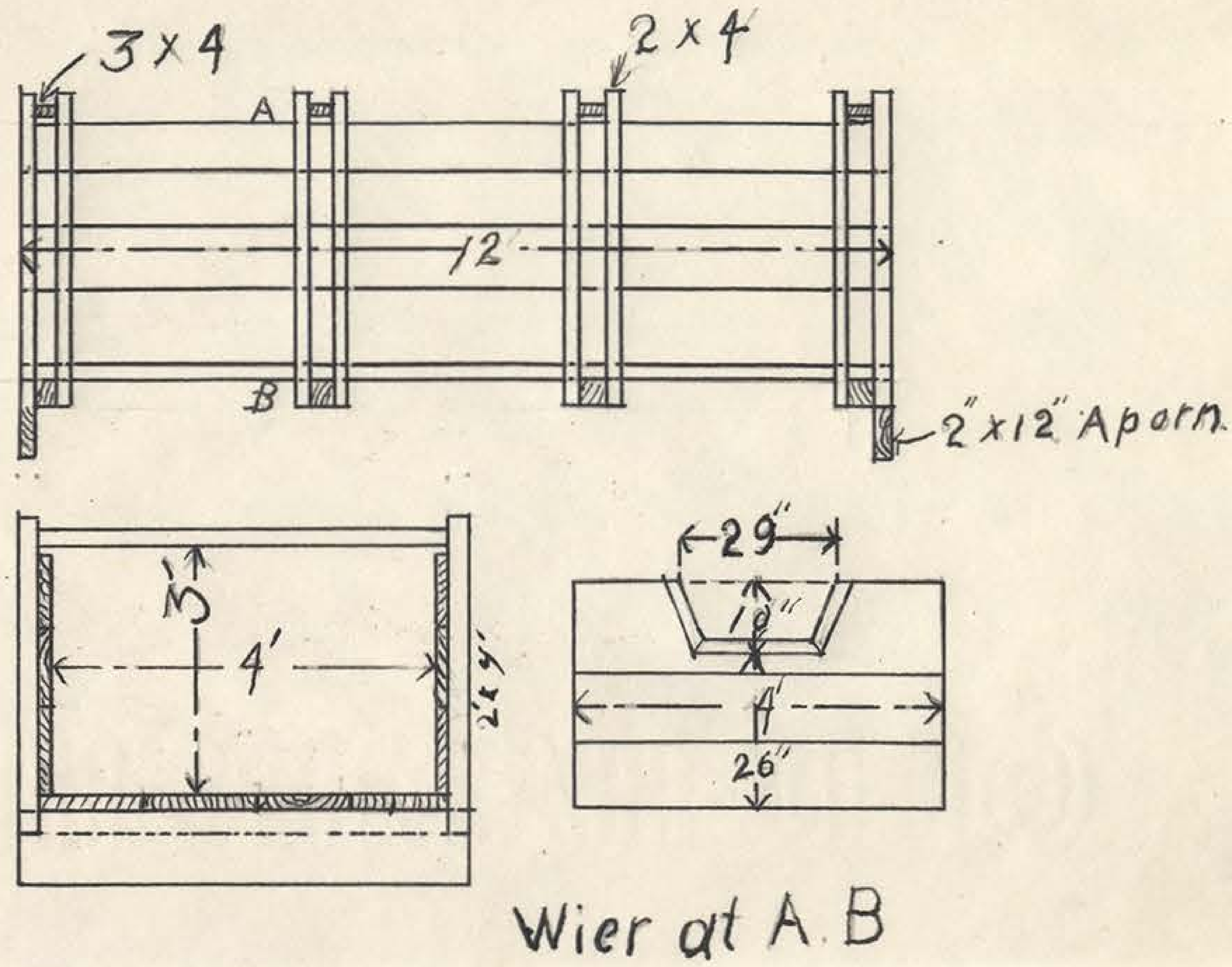

fig. 3. Plan of Weir Box.

The depth of water flowing through is measured by a guage, placed about four feet above the Weir board. The zero of this guage is on a level with the bottom of the notch. Thus, if the depth of the guage is six inches, the flow through the 24" Weir shown in figure 3 would be 95 miner's inches.

Land for irrigation should be prepared after the building of a supply ditch, because it will be found better to grade the land in conformity to permanent ditches already constructed, than to locate and excavate ditches to suit land that has been graded and leveled.

Settlers do not appreciate the importance of preparing the surface of fields so that they may be cheaply and easily watered. Crops are good or bad accordingly as they have received the proper amount of water at the required time, and then if the gound is left rough or uneven the water cannot be evenly applied. Consequently, a reduction in the yield is the result. Again, land that is properly leveled the first year will diminish a great deal of time and profits will be greater, and the cost for operation will be materially lessened.

Land that can be reclaimed by cultivation and irrigation is usually more or less covered with native vegetation of one sort or another. In Idaho sage-brush is the native vegetation. The best and most satisfactory clearing is where as much as possible of the root is removed with the brush, and then the brush must be well cleared up and burned. Where the brush is of the smaller form it can be readily plowed under. Such plowing should be deep and the coarse material removed, but this is not a good method, as the smaller brush is turned under and covered over. It remains in the bottom of the furrow, and holds the plowed soil apart from the sub-soil, which prevents a close capillary connection that should exist, and it is not a wise plan to plow before grading.

Railing is the prevailing method that is in use to remove the brush. It is first railed by dragging an eighty pound rail, 18 feet long, across and back over the same strip in opposite directions by hitching a team of horses to both ends. In this method all of the brush is not torn up, but the remainder is easily grubbed.by hand with a mattock. The loose brush is then gathered into windrows or piles by a common hay-rake and burned.

The cost of removing and burning a growth of brush as described above is about $3.00 per acre.

The amount of grading that land may need for the application of water varies with the lay of the land. In some field the surface and slope are so even that very little levelling is required, but where knolls occur that must be scraped off and depressions filled. In such cases as this a great deal of work would be required. A very good implement for this work is the Tongue Scraper. No more levelling should be done than is necessary, as the humus accumulated in the soil is not very deep, but if ther is a deep soil heavy grading may be done. Grading should be done so thoroughly that when the water is turned on it may be evenly distributed on the land. The main idea in levelling then is to so fashion the land that the water may be distributed evenly.

When the field has been leveled and graded, the method of applying the water must be determined. These may differ widely because of the diversity in soil and sub-soil, and in the nature of the water supply, the size of the farm, and the envirnment of the irrigator.

The methods of applying the water are:- The flooding method, the check method, the border method, and the furrow method. There are still other methods, but these are the methods mostly used in Idaho where the lay of the land will permit.

Flooding the surface of the land from the field lateral is the prevailing method used in the mountain states. The method is quite well adapted to this mode of applying water. It can be used on quite steep slopes and various other ways fits in with the requirements of the irrigator on the more elevated lands. It is essential that the levelling, grading, and smoothing the surface be of such a degree that the water will readily flow over it. To distribute the water over the field small ditches must be located and constructed along the best routes. These form a net-work of little ditches, which cuts the field into small strips, the space between the ditches varying according to the lay of the land, smoothness of surface, and the volume of water that can be obtained. This method can be used where the slope is too great for other methods, as a field that has a firm soil and a fall of from 15 to 65 feet may be flooded successfully. Its cheapness is another feature, as ordinary raw land can be prepared at an expense of about $2.00 per acre. Where the water supply is limited this method is of an advantage, as it is adapted to the use of small water supplies. In applying the water by this method there is no set rule, as the irrigator must use his own judgement as to where the laterals and checks must be put in.

On land that is nearly level, where it is difficult to spread the water over the entire surface the check method may be used. This consists of dividing the field into checks, or compartments, each having a fairly level floor space surrounded by a low flat levee and a bordering supply ditch.

Checks are made in one of two ways, and are known as the "rectangular" and the "Contour". The boundaries of the former are straight, while the boundaries of the latter conform to the natural slope of the land. The most favorable conditions are a light sandy soil and an even slope, three to fifteen feet to the mile, abundantly supplied with water. This method may be used on heavy soil where it is necessary to hold the water in order to secure the percolation to the desired depth. The chief advantage of this method is that one man can irrigate from seven to fifteen acres in ten hours. Also, to counterbalance this a considerable amount of surface soil is removed, which in many cases decreases the yield, and the method is not adapted to rotation of crops.

The border method consists of a division of the field into long narrow strips or lands by low flat levees, which usually extend in the direction of the steepest slope, and can confine water to a single strip. The bed of each strip is carefully graded to a uniform surface, but the slope may change to conform to the contour of the natural surface. The water for each strip is taken from the head ditch extending across the upper edge of the field. Canvas dams or check gates are used to hold the water up in the head ditch in order to cause the water to flow into the borders. This method is best adapted to the irrigation of alfalfa, and can be used to advantage on canals which deliver water to the users in large streams, as the smallest head that can be used successfully is seldom less than from two to three cubic feet per second. It is especially adapted to light open soils, into which the water may percolate rapidly.

In the preparation of the beds the land is first leveled, then plowed and harrowed, after which the borders are marked off and thrown up by plowing two to four furrows with a heavy plow. The cost of preparing land in this way and seeding varies from $10.00 to $30.00 per acre, depending of course upon the roughness of the surface. This method enables one man to irrigate a large area with a minimum of labor providing a large stream of water is available.

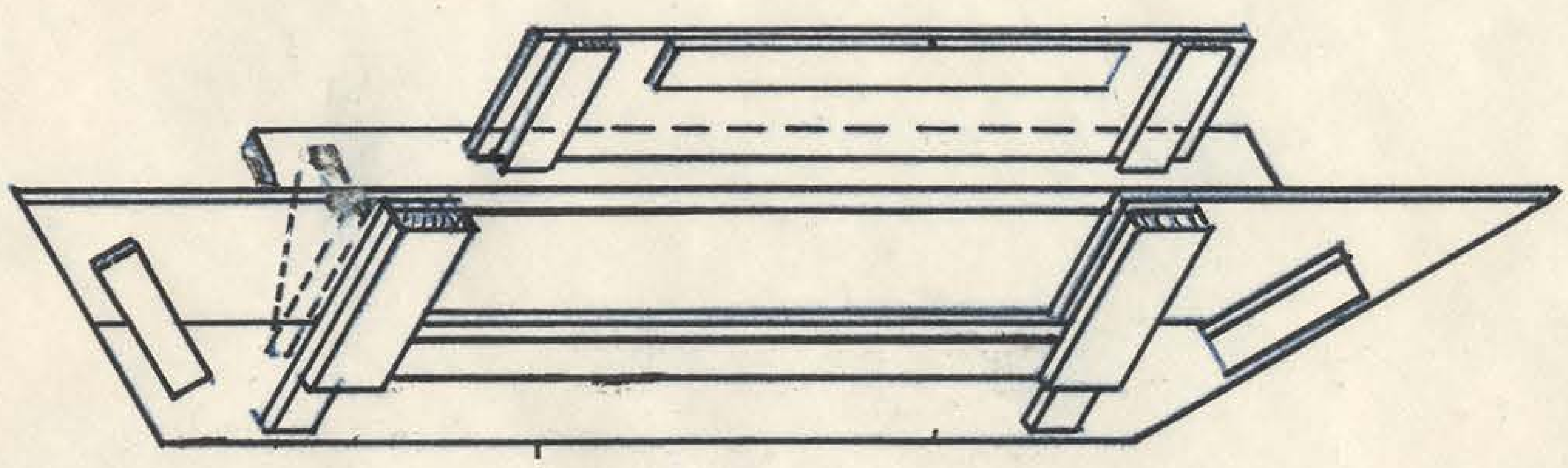

fig. 4. Border gate used in California.

Forage crops are commonly irrigated by one of the other methods previously described rather than by the furrow system, as this is the usual method of irrigating gardens and orchards, but it is practiced to some extent in the Snake River Valley in Southern Idaho. In this section the soil is a fine clay loam, which runs together, puddles when wet, and bakes in cracks when dry. In the flooding of the surface of such soils the top layer is puddled, which becomes very hard when the moisture is evaporated. Such a process as this injures the crop. The object of the furrow system in this case is to keep as much of the surface as dry as possible. Consequently, when a small stream is permitted to run in the bottom of a furrow for several hours, the soil beneath becomes wet for some distance, while the surface remains dry.

For the irrigation of most of the crops grown in this country the feed ditches are laid out across the fields as nearly parallel as possible on a grade of from two to six inches and from three hundred to five hundred feet apart. Furrows are made in the direction of the greatest slope at right angles to the feed ditch if possible, starting at the ends. A wooden check is inserted in the ditch at the end of each fall of twelve inches. Each check box is provided with a removable flash board, which when in place backs the water to the next check above, and at the same time permits the surface water to flow over ~~to~~ its top to supply the check below. Lath tubes are inserted in the lower bank about three inches below the water level formed by the flash board when in place. This is done in order that they may all be on the same level. The flow from each tube may be divided among several lines.

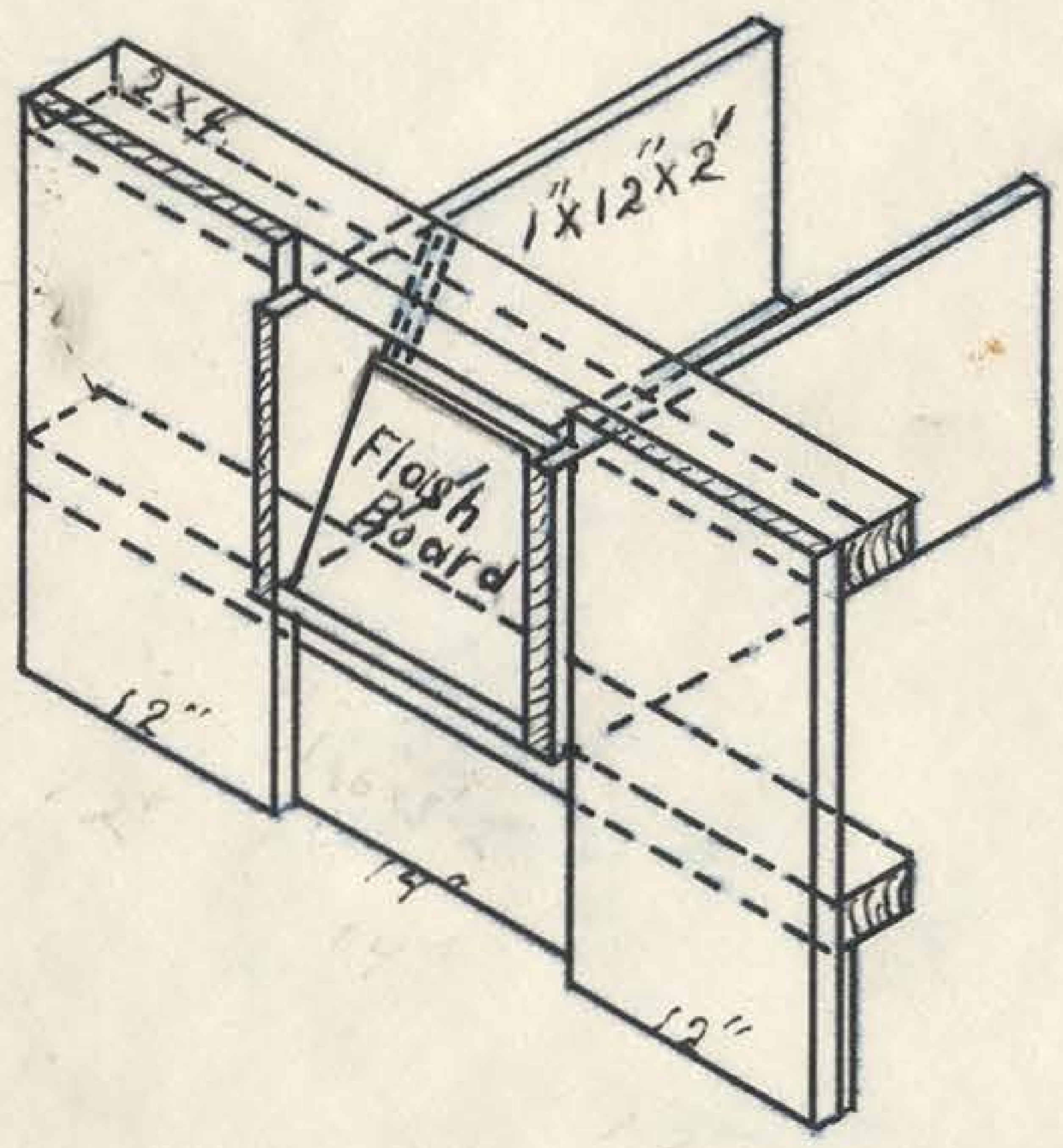

fig. 5. Check box for furrow irrigation.

For the making of the furrows a marker is generally used, on the under side of which are bolted three or four runners according to the dimensions of the platform. The front end of each runner is shappended and shod with steel. Owing to the difference in soil the markers should be constructed to suit, as in soils where the water percolates readily they need not be closer than eighteen inches apart. The furrows should be about three inches deep and five inches wide at the top.

From recent investigations it has been shown that the quantity of water a plant uses forms but a small part of that which is diverted from streams for irrigation. Any amount is lost by absorbtion and seepage in the canal system. Losses also occur in the ditches which supply the farm, and a large part of the remainder is waisted in irrigating the crop. The settler is chiefly concerned in lessening the waiste of water in his supply ditch on the farm. These losses may be prevented to a great extent by a clay puddle or by using crude oil.

Insufficient preparation of the surface is one of the most common sources of loss of water. An uneven surface causes a waiste of water, extra labor in applying the water, and a smaller crop yield. Water flows into the low places which receive too much water and may become water-logged, and may also cause injurious salts to occur, while the higher places are left without water and the crop thereon is dwarfed. Consequently, the surface of the field should be so evenly graded that the water will flow in a thin sheet over the entire surface, and the excess water should be caught up by the lower laterals or waiste ditches.

Water is often turned on a field and permitted to run without attention for hours. Under this practice the low places receive too much and the high places little or none, and a large part flows off the field to injure thr roads and adjoining farms.

Too shallow and frequent irrigation is another source of waiste. For most plants and for all deep rooted plants, in particular, the ground should be so prepared that the water will readily percolate to a considerable depth beneath the surface, and enough water should be applied to moisten the sub-soil.

The amount of water to apply in one irrigation, the length of the interval between irrigations, and the amount of the water used in any one season depends on the soil, crop, and climatic condition.

The main purpose of irrigation is to furnish the required amount of moisture to the soil upon which the crop is grown. Too little as well as too much moisture injures plant growth. The lavish use of water is the direct cause of many serious irrigation difficulties. In fact, it is better to have a scarsity of water in some cases, for as long as a farmer has an abundant supply of water he invariably yields to the temptation to use it freely. It is not an easy matter to find out how much is best for each kind of soil and each kind of crop, but the best method is to make inquiries and take observations from his own field and apply the water as the irrigator thinks best to secure the desired results.

Excessive irrigation leaches the soil, fills it with water to the exclusion of air, and it interferes with the activities of the micro-organisms upon which the crop plant depends for their food supply. Good tillage produces the opposite result. A wet soil remains cold, while a well tilled soil warms up quickly and favors plant growth. The proper percentage of moisture in the soil has been determined to be about one pound of free water to ten pounds of soil. This percentage may be determined by obtaining a soil auger and a balance scale to weigh the soil. The sample should be taken from the roots of the plant at various depths. The samples should then be placed in an air tight jar to prevent the evaporation of moisture. An even number of ounces is taken. Assume fifty ounces to be the weight before drying. The sample is then spread out in a thin sheet and allowed to dry for a day. If it weighs only forty ounces when weighed again, this will indicate that there is one ounce of free water for every ten ounces of soil. If the sample weighed about thirty five ounces it would indicate that there was not enough moisture for rapid plant growth, in which case, water should be applied.

The above rule will indicate whether there is sufficient moisture in the soil in case the one concerned is not able to determine it from observing the crop. In this case if there is not sufficient water the plant will begin to wilt and dry up, while on the other hand if there is too much water the breathing pores of the plant will become saturated with the water, causing the plant to take on a yellowish color; but this cannot be always depended upon, as the temperature, diseases, and lack of air in the soil may cause the same effect.

The proper amount of water to apply in any one irrigation cannot be stated definitely, especially upon new land, but the usual method which prevails in the southern part of Idaho under the free flooding method is to divert the water from the lateral at its highest point and allow the water to spread out over as much surface as possible, which is usually from three to seven acres. By the time the water has reached the furtherest point of the plot that is being irrigated it is considered that enough water has been applied to wet the soil to a depth of twelve inches, provided the head varies from fifty to eighty miner's inches. The application of four inches of water in depth over the surface of a field is sufficient to moisten the soil to a depth of three feet. In the process of the distribution downward there is a large amount waisted, but the greatest loss is from the surface into the air. Water should not be applied in access, as in time the soil will be saturated with water, in which case the injurious salts will be disolved, and the evaporation of the water from the ground brings the salts up to or near the surface. Unless natural drainage is present or artificial ones are created, the land from this excessive irrigation will become too wet or too alkaline for the growth of crops. Some of our best soils have perfect natural drainage. They are underlaid with strata of material which gives free passage to the surplus water. On the other hand, other soils are just as rich in natural fertility, which are unproductive, because under ordinary circumstances they contain too much water. No matter how this surplus water occurs, it must be removed before the soil will be in proper condition for plant growth. Drainage either natural or artificial, only regulates the quantity of water in the soil by providing means by which the surplus may pass off, and in no case removes the moisture required for plant growth, because such moisture is retained by the particles of soil. Consequently, in the selection of a location the settler should keep in mind the drainage of the soil.

Good preparation of the land for planting is very important. The soil should have a mulch of loose soil about two inches deep over the surface, and should be quite firm, below this mulch and a firmer soil will be insured. By plowing in the fall the surface can be worked up into a better seed bed in the spring. This cultivation should be done as soon as possible, as it will conserve the moisture. After the heavy freezing is over the seeding may be done. There should be sufficient moisture in the soil to bring the crop up and keep it growing until it is six or seven inches high, when the water may be applied if needed. On the other hand with spring plowing it is difficult to get a firm seed bed, and especially one that will retain the moisture well enough for best results. The soil will be loose and dry quickly. In spring plowing it is best to irrigate before seeding unless ther has been an abundance of rainfall.

Seeding for most grasses may be done at any time during the growing season, unless ther is danger from heavy freezing. This is especially true of alfalfa. For best results the seeding should be as early in the spring as the soil will permit, depending of course upon the location, as to altitude and climatic conditions, although a light frost will do no serious damage. The amount of seed used if done with a drill should be about eleven to twelve pounds to the acre of first class seed. If sewed broadcast fifteen to twenty pounds may be required. Under the methods of irrigation it is better to have a thick rather than a thin stand. The use of a seeder is a better method, as the seeds are covered, and each seed is given an equal chance with every other seed for germination. In seeding raw land it is best not to use a nurse crop. If sewed alone it will become well established and make a fair yield the first year, while the second year's yield will be greater than if a nurse crop were used. On the other hand, if seed is sewed with a nurse crop a spindling growth is produced the first year, and the root system and crown are not strong enough to bring returns the second year. If seeding is done, late summer or early autum no treatment will be necessary unless a growth of twelve inches is prodcued before cold weather sets in. If this does occur the plant should be clipped back so that they will grow into winter with about eight inches of growth, as in this condition they will be able to withstand the winter and will be in shape to renew their growth the following spring.

The first irrigation of the young plant should be withheld as long as possible and no water applied until there is real need of moisture, as early irrigation and an abundant supply of moisture will tend toward shallow rooting.

As to the frequency and amount of water required for any one irrigation, the climate and soil condition must determine the proper treatment. Irrigation in the spring should not begin until warm weather has arrived, and then not until the moisture condition of the soil requires it. Injury may be done if the weather is very cold.

The amount of water to be applied should be judged by the knowledge of the crop, as some require more water than others. The deeper the soil the more economical the water may be used, and the less frequent the irrigation. No definite idea can be given as to the amount of water to apply in any one irrigation, but for most crops an average of about six inches in depth, or half an acre-foot per acre may be applied at any one irrigation.

In localities where water is cheap and plentiful it may make little difference as regards the annual cost of the water whether the farmer uses six inches or twelve inches. The effect of the proper use of water at each irrigation, however, will soon be apparent, in the yield of the crop and the fertility of the soil. It should be understood from the start that irrigation water cannot take the place of cultivation. The labor and skill of the husbandman are needed even more in an arid than in a humid climate. From experiment it has been shown that excellent crops of all kinds can be grown with a medium amount of water provided the soil is well cultivated and the water applied carefully when needed.

Irrigation is recognized as an agricultural art of very wide value. Its association with the idea of desert reclamation has blinded the public mind to its value for regions where the need of reclamation does not exist. Irrigation is a means of improvement to be employed like other means of improvement when the soil needs it. Water is the most important food of plants, not alone because it enters in such volume in their tissues, but because with it in adequate amount the plant cannot use other food in sufficient quantity. No one questions the saving and storing of manures. The same is true of soil improvement by means of drainage. There should be a similar feeling in regard to irrigation.

Irrigation is not a recourse to insure the safety of a crop. It has been demonstrated beyond question by practical experience that growth and production can be properly furnished by irrigation even when the natural moisture seems ample. In this respect it lends itself as a factor in intensive culture.

Another error grows out of the large scale upon which irrigation is generally known to be carried on, involving canals and ditches too expensive for individual undertakings. This however is not the case, as it lends itself to the smaller individual as well as the large co-operations.

Consequently, in selecting new land to be put under irrigation the settler should take into consideration the whole situation as to location, as to the water supply, the lay of the land, and its requirements for water;-- The character of the crop and soil, the location of ditches, the labor requirements and the levelling of the surface.

As to the profits to be obtained under irrigation, the one concerned should take into consideration the feeding value of the forage crop, as it is so high that the greatest profits can be obtained usually by feeding it to farm animals. When sold in the stack the net profits vary between somewhat large limits. From the statement which follows some idea may be obtained as to the profits to the grower under skilful practice.

Annual cost of water per acre	$1.00
Clearing and repairing farm ditches	.50
Annual taxes	.60
Cost of applying water during season	1.50
Cost of marketing and harvesting 7 tons at $1.65 per ton	11.55
Annual depreciation of hay tools, irrigation structures, etc.	2.00
ANNUAL EXPENDITURES	$17.15
Average yield of 7 tons at $8.00 per ton	$56.00
ANNUAL PROFITS PER ACRE	$39.85