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FIBER GLASS AUTOMATIC IRRIGATION GATES*

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ABSTRACT

Irrigation structures constructed from an alloy of acrylic and PVC with fiber glass reinforcing are being developed to automatically control water in farm irrigation systems. Fiber glass has certain advantages over many materials for this use because it is strong, lightweight, and durable. Some gates operate automatically; others are semi-automatic. Sinking float and center-of-pressure metal prototype gates for border or other surface flooding methods have been tested in a laboratory flume, a border-irrigated field, and on a Hawaiian sugar plantation.

SOMMAIRE ET CONCLUSIONS

Actuellement, on développe des ouvrages d'irrigation fabriqués d'un alliage de fibre acrylique et de "PVC" armé de fibres de verre, pour le contrôle automatique des eaux dans les systèmes d'irrigation agricole. Les fibres de verre, pour cet usage, présente quelques avantages sur un grand nombre de matériaux : résistante, légère, durable, facilement moulable en diverses formes, d'un entretien facile et peu fréquent, ne nécessitant pas de peinture et résistante à la corrosion.

Les vannes à flotteur submersible peuvent être facilement et économiquement construites, en réalisant des accessoires comme le flotteur et pièces de renfort ou nervures directement sur la vanne. Ceci est réalisé

* Vannes automatiques en fibre de verre.

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en moulant à vide l'alliage de fibre de verre préalablement chauffé. Pendant l'opération, l'équilibre est maintenu ouvert par le flotteur quand l'eau est admise dans le canal. Quand l'air échappe du flotteur, à un moment déterminé par une minuterie ou tout autre dispositif, la vanne pénètre dans l'eau et se ferme pour finir l'irrigation. Actuellement on fait des essais des minuteries, tant mécaniques que électriques, pour les utiliser avec les vannes.

On peut citer d'autres types de vannes, sans flotteur, construites de la même façon comme les vannes à centre de pression, rabattantes normalement ouvertes et à tablier ou oscillantes normalement fermées.

Des prototypes de vannes en métal ont été essayés en laboratoire, sur un terrain avec arrosage à la planche et sur une plantation de cannes à sucre. Ils ont été essayés principalement sur des canaux sans revêtement, cependant ces types de vannes peuvent aussi bien être utilisés pour des canaux avec revêtement. On peut installer les vannes d'une manière permanente sur un mur amont, ou sur un châssis portatif dans le cas d'automatisation d'installations déjà existantes.

Les herbes et les objets flottants doivent être contrôlés ou éliminés du système, parce qu'ils peuvent gêner le fonctionnement des vannes. D'une manière générale l'utilisation d'appareils automatiques oblige à apporter une plus grande attention au curage des canaux.

The application of modern technology offers exciting possibilities for today's irrigation farmer. It is providing improved structures and practices for increasing irrigation water use efficiency, while at the same time decreasing labor requirements. One example is the use of synthetic materials, such as fiber glass and plastics, in the construction of automatic structures and controls. Sinking float and pressure gates manufactured from fiber glass are being developed to automatically control water in farm irrigation systems. Fiber glass has certain advantages over many materials for this application. It is lightweight, durable, can be molded into various shapes, has a low maintenance requirement, does not require painting, and is corrosion resistant. Fiber glass structures can also be mass produced. Various appurtenances molded directly into the structure require less fabricating labor than if made separately and manually mounted as would be required if made from other materials. Because of their light weight, fiber glass structures are well suited for portability and are economical to ship.

STRUCTURE DESCRIPTION

SINKING FLOAT GATE

The fiber glass gate shown in Figure 1 is constructed from an alloy of acrylic and PVC with fiber glass support or reinforcing. A float is formed near the bottom on the downstream side. It is molded directly into the gate by heating the fiber glass alloy sheet to about 204°C (400° F) and then placing it over a pattern and applying a vacuum for shaping. The side of the depression thus formed is closed with a flat sheet to form the float. An opening in the bottom of the float allows water entry while a tube in the top allows air to escape. Reinforcing flanges or ribs are formed into the

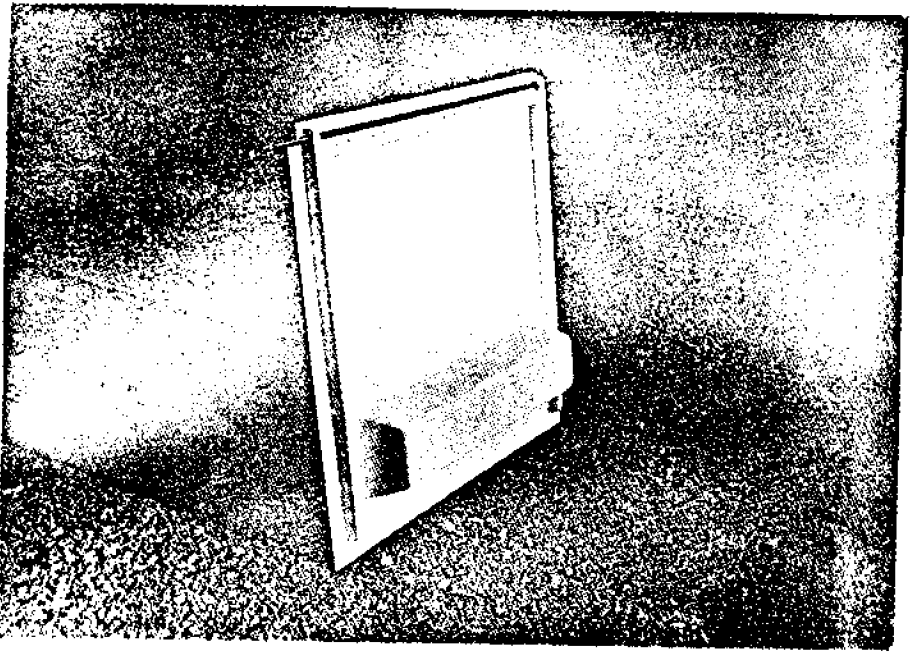


FIGURE 1 : Fiber glass sinking float gate for mounting on portable frame or headwall structure.

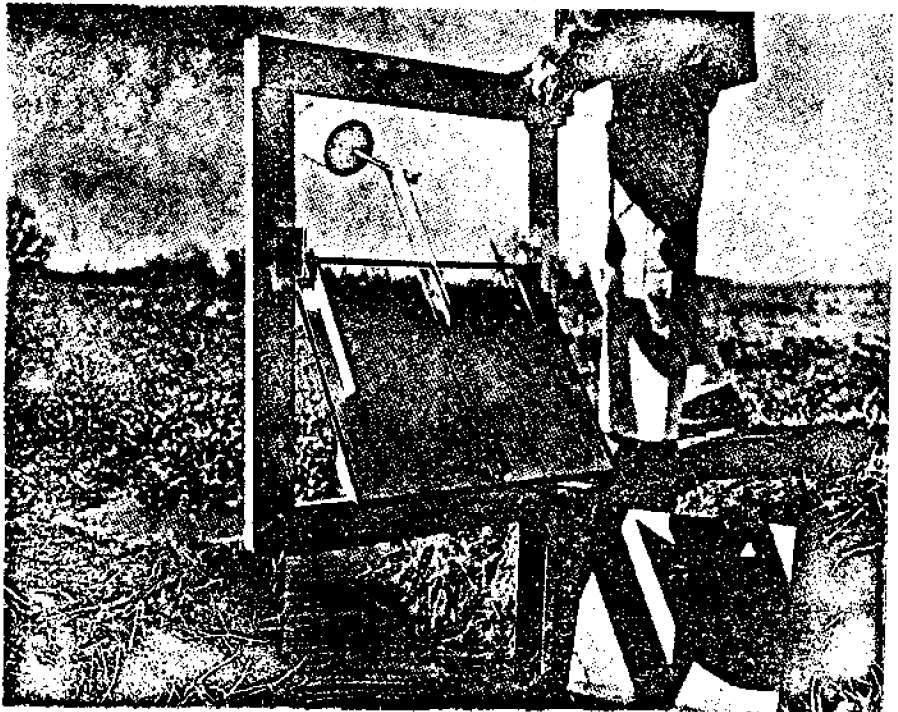


FIGURE 2 : Portable sinking float gate for use in existing structures.

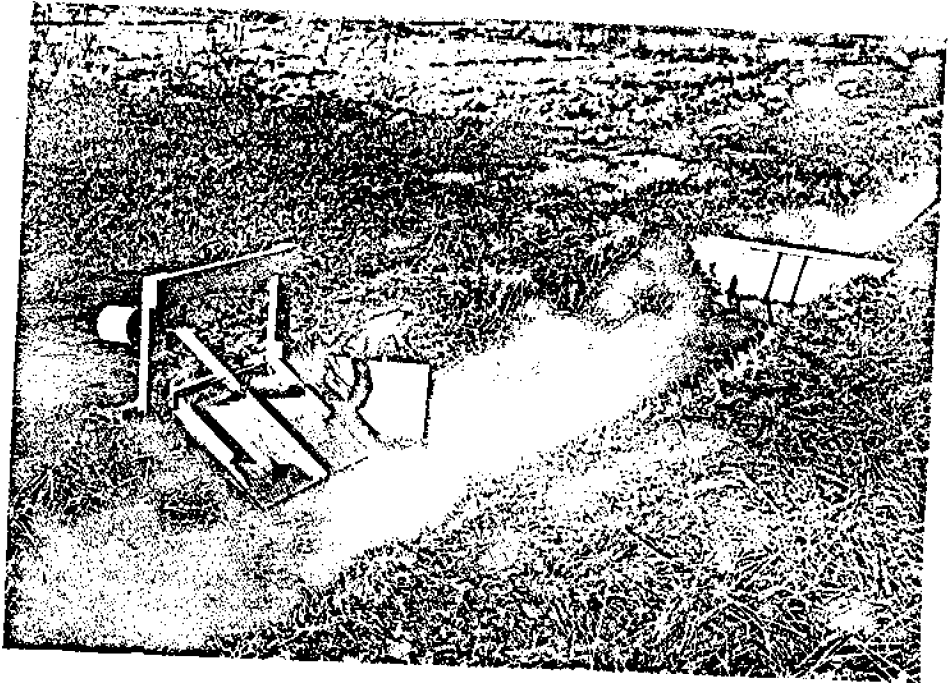


FIGURE 3 : Automatic gates being used for border irrigation.

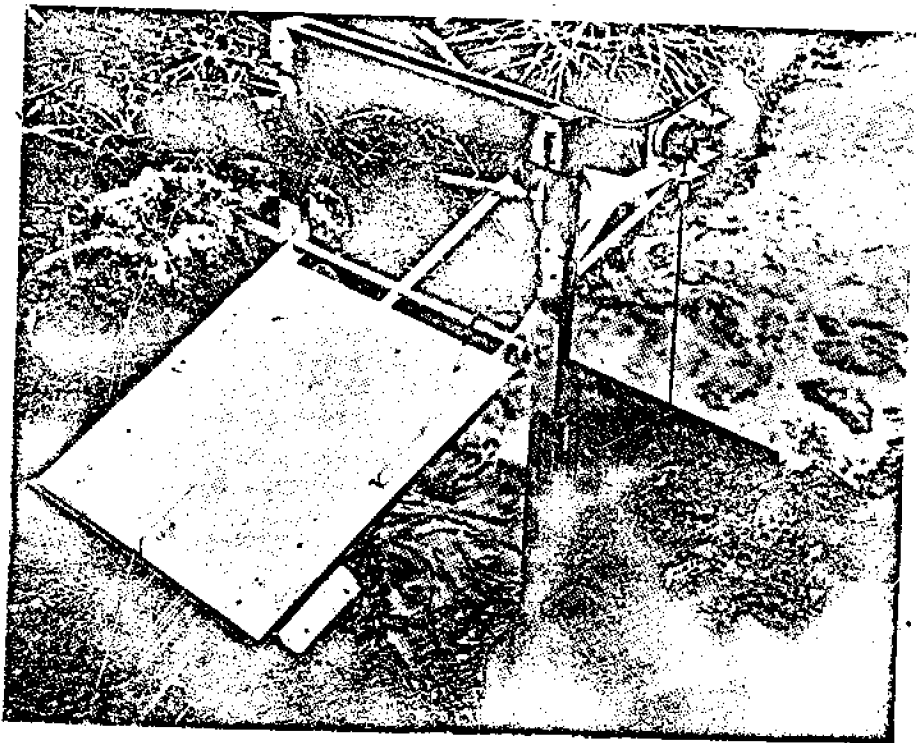


FIGURE 4 : Timer-controlled check gate used to irrigate sugar cane.

gate to provide strength and rigidity. The gate is hinged with a shaft near the top edge. For heavy duty service, nylon or metal bearing inserts may be cast into the supporting flanges through which the pivot shaft is placed. The gate, counter-balanced with a spring or a counterweight, assumes a partially open position approximately 35 to 45° from the vertical when water is not in the ditch. A neoprene or butyl rubber strip cemented to the downstream side of the gate provides an effective seal between the gate and the frame or headwall on which it is mounted.

The float is located as near the bottom of the gate as possible and extends outward from the downstream side of the gate. With the gate in its normally open position, the float bottom extends below the lip of the gate and is the first to come in contact with water.

Air is released from the float at a controlled rate for irrigation timing by varying the length and diameter of teflon capillary tubing, or with an air bleed valve operated by a mechanical timer, or an electric solenoid. In some cases, the mechanical timer can be automatically rewound for timing the next irrigation when the gate closes. An escapement lock is used to prevent the timer from running, after being reset, until water enters the ditch for the next irrigation. A battery-operated electronic timer can also be used to control the air escape. This has certain advantages over a mechanical timer because it has no moving parts and can be sealed from dust and moisture. An electronic timer requiring a small amount of current can be operated from a low voltage battery.

The gate can be installed on an irrigation structure headwall for an integral unit, or it can be mounted on a portable frame as shown in Figure 2. The portable gate is placed in a conventional structure having checkboard guides or notches. Used in this manner, it is possible to automate many existing structures.

The sinking float gate is designed so that the normal water depth in the ditch is approximately 0.4 to 0.6 times the distance from the bottom of the gate to the hinge point. To function properly, the gate should be operated with the flow depth within this range. Below the minimum operating depth, the gate may not be held open far enough to create the necessary differential pressure within the float to cause sinking and also the hydraulic force acting on the gate may not be large enough to close it. The air pressure within the float varies with gate position as determined by water depth. When a capillary tube is used to control air escape from the float, the timed irrigation is approximately inversely proportional to the inside float pressure. Thus, the time for which a particular tube is calibrated will vary if the gate is not operated with the approximate design flow.

In operation, when water is admitted into the ditch, the float provides a buoyant force to hold the gate open. When air escapes from the float, the float loses buoyancy and sinks. Water flowing through the gate opening is intercepted and closes the gate to terminate irrigation. The gate is automatically reset when the float drains after an irrigation.

PRESSURE GATE

This gate is also constructed from a plain fiber glass alloy sheet with stiffening flanges or ribs to provide strength and rigidity. The gate turns

on a horizontal pivotal shaft located a distance y from the bottom of the gate where

$$y = \frac{1}{3} (d - 3.5)$$

where d is the water depth in centimeters at which the gate opens. Cracks around the edges are sealed by cementing a continuous rubber strip on the upstream side of the gate. Above the pivot axis, the rubber is cemented to the frame or headwall to which the gate is mounted; below the pivot axis, it is cemented to the gate. The gate is counterbalanced by either a spring or a metal weight.

In operation, the gate opens automatically when water reaches the design depth on the upstream side and remains open as long as water flows through it. After irrigation, it automatically returns to its normally closed position.

OTHER STRUCTURES

Normally open drop gates and normally closed swing-open or apron gates can also be manufactured from fiber glass. These are constructed similar to the sinking float and pressure gates except for the float appurtenances. They consist of a flat sheet with stiffening ribs and flanges hinged either at the top or the bottom and have a rubber seal on the edges.

The use of fiber glass need not be limited to the gates described. Although not tested, it may be practical to construct headwalls with a "sandwich" type construction using fiber glass sheets with a honeycomb or other type core.

FIELD INSTALLATION AND OPERATION

Although most of the gates described above have been field tested in unlined ditches only, they can also be made for lined ditches. When the sinking float gates are used as border turnout gates, they should be installed with the bottom of the opening below field elevation. This provides tailwater for good gate operation and minimizes erosion at the turnout. The operating water level in the supply ditch should be determined before setting the pressure gates. The pressure gate is installed so that the normal water depth in the ditch is at least 3 cm (1.2 inches) below the gate-tripping depth. This increment of water depth is required to open the gate. If the water level is too near the gate-tripping depth prior to the scheduled opening of the gate, the gate is near a balanced position and some leakage occurs around the seals.

Floating trash can interfere with the gate's operation and should be removed from the system. Small pieces of trash normally are not objectionable; however, large pieces or long-stemmed plants can become lodged in the gates. In unlined ditches, uncontrolled weed growth can increase the water depth, and may cause premature opening of the pressure gates. Water carrying a large amount of sediment may also be troublesome since sediment deposits in the vicinity of the gates may prevent them from completely closing. Normally greater attention is required to maintain clean ditches when using automatic structures than when an irrigator is present. Most

irrigation structures obstruct ditch cleaning equipment to some extent. Tractor-mounted ditches can often be raised to clear the structures, but some hand shoveling may be required adjacent to the structures. The gates can be damaged by open flames used for weed control if proper care is not exercised. When the ditches are maintained in good condition, fiber glass structures will normally require very little maintenance.

The structures described in this paper are well suited for border and contour ditch irrigation where surface flooding methods are used.

FIELD TESTS

Metal prototype gates were tested in a laboratory flume, in a border-irrigated field, and on a Hawaiian sugar plantation. The field operation of fiber glass gates is the same as for those made from metal. Test gates being used for border irrigation are shown in Figure 3. These were cycled repeatedly late in the season after crop harvesting for a period of about 2 weeks. Short irrigation times were used so that the gates could be cycled once or twice each day. A timer-controlled sinking float gate was cycled about 25 times during this period without any failures when an adequate irrigation stream size was used. At temperatures below approximately 5°C (41° F), some difficulty was experienced with water condensing in the small stainless steel tubes used for timing the turnout gates. This did not occur during the summer irrigation season and should not be a problem with small-diameter teflon hypodermic tubing being tested for this purpose. The companion pressure gates functioned repeatedly without any failures during the field tests.

A metal prototype gate being tested for irrigating sugar cane is shown in Figure 4. Most of these gates were mounted on portable redwood frames, which, in turn, were installed in existing "box" structures normally used on the plantation; thus, structures already in use were converted for automatic operation. Ten of the gates designed for a 5- to 7-cfs (cubic feet per second) stream size were installed in pairs with pressure gate companion structures. Because the irrigation ditches were constructed on a flat slope, an increment of water depth could not be obtained to trip the pressure gates. Therefore, a small stainless steel cable was used to trip them when the sinking float gates closed. Sinking float gates for an irrigation stream size of approximately 3 cfs were tested in two lateral contour supply ditches, Figure 4. These were used to divert water from the supply ditch into metal distribution flumes placed normal to the contour irrigation furrows in the downslope direction.

SUMMARY AND CONCLUSIONS

Irrigation gates constructed from an alloy of acrylic and PVC with fiber glass reinforcing are being developed to automatically control water in farm irrigation systems. Fiber glass has certain advantages over many materials for this use because it is strong, lightweight, durable, can be molded into various shapes, has a low maintenance requirement, does not require painting, and is corrosion resistant.

Sinking float gates are simple and can be economically constructed by forming appurtenances, such as the float and stiffening flanges or ribs

directly into the gate. This is done by heating the fiber glass alloy and then placing it over a pattern and applying a vacuum for shaping. In operation, the counterbalanced gate is held open by the float when water is admitted into the ditch. When air is released from the float by timers or other means, the gate sinks into the water and closes to terminate irrigation. Both mechanical and electrical timers are being tested for use with the gate.

Other gates similarly constructed, but without the float appurtenance, include center-of-pressure gates, normally open drop gates, and normally closed apron or swing-open gates.

Metal prototype gates have been tested in a laboratory flume, in a border-irrigated field, and on a sugar-cane plantation. They have been tested mostly in unlined ditches; however, they can also be used in lined ditches. The gates can be permanently mounted on a structure headwall or on a portable frame for automating existing structures.

Weeds and floating trash need to be controlled or removed from the system because they can interfere with the gate's operation. Normally, ditches must be kept cleaner when using automatic structures than when an irrigator is present.