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## IV

### **Barge for the Beaching of a Railway Ferry**

Équipement d'abordage pour un bac ferroviaire

Anlegungsanlage für eine Eisenbahnfähre

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### **SUMMARY**

A set of expedient equipment for steering the ferry boat inshore is recommended in this article. It consists of three main parts: the hull, the anchoring device and the counterweights. The work done in raising the counterweight absorbs the kinetic energy produced during the beaching proceeding. The design, which has gained wide approval, is characterized by the absence of heavy underwater work, high efficiency, guaranteed safety, good reliability, low cost and minimal maintenance.

### **RESUME**

Cet article recommande un nouvel équipement d'abordage pour bac ferroviaire formé de trois parties principales: coque, système d'ancrage et contrepoids. Il s'agit d'absorber avec le travail de soulèvement du contre-poids l'énergie cinétique produite par le bac, qui passe au moment de l'abordage de l'état de mouvement à l'état de repos. Cet équipement ne nécessite pas de fondation sous-marine et se distingue d'une façon étonnante par son efficacité, sa sécurité de fonctionnement et une économie en matière d'investissements et d'entretien.

### **ZUSAMMENFASSUNG**

In diesem Artikel wird eine neuartige Anlegungsanlage für Eisenbahnfähren empfohlen; sie besteht im wesentlichen aus 3 Teilen: Schiffsrumpf, Ankersystem und Gegengewicht. Die kinetische Energie, die beim Anlegen entsteht, wenn die Fähre aus dem Zustand der Bewegung in den der Ruhe übergeht, wird durch das Heben eines Gegengewichts aufgefangen. Bei dieser Anlage werden keine Unterwasser-Fundamente benötigt; sie zeichnet sich durch eine hohe Leistungsfähigkeit, sicheres Funktionieren und niedrige Investitions- und Unterhaltskosten aus.

A weak link occurs when a ferry is used instead of a bridge on a railway line. The ferry delays the transportation, so adequate measures must be taken to shorten the time lost. A set of equipment has been designed for this purpose as shown in Fig. 1. Three of them are reinforced concrete pile bents. No.1 and No.2 Bent are set on the front of the approach bridge to protect the bridge from the bumping of the ferry boat and to fix the forepart of the ferry boat in a fine condition for interlocking the ferry boat with the movable hinged span

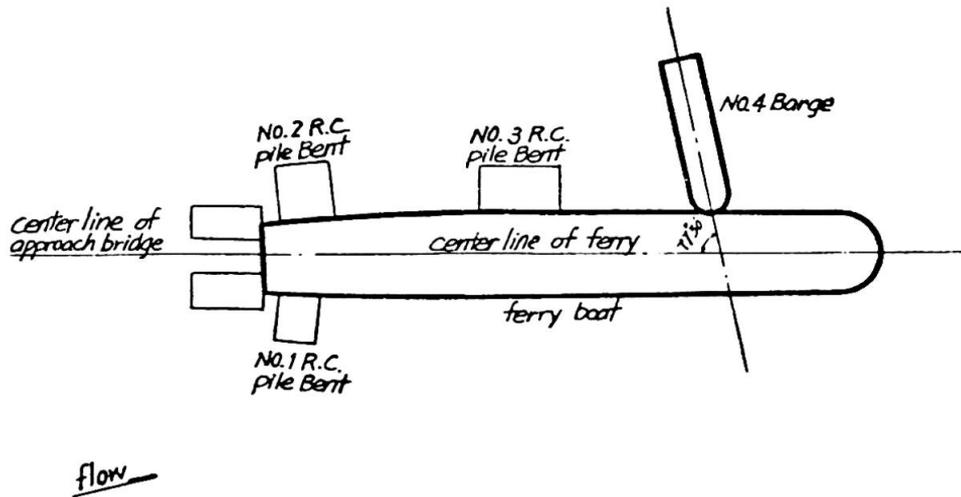
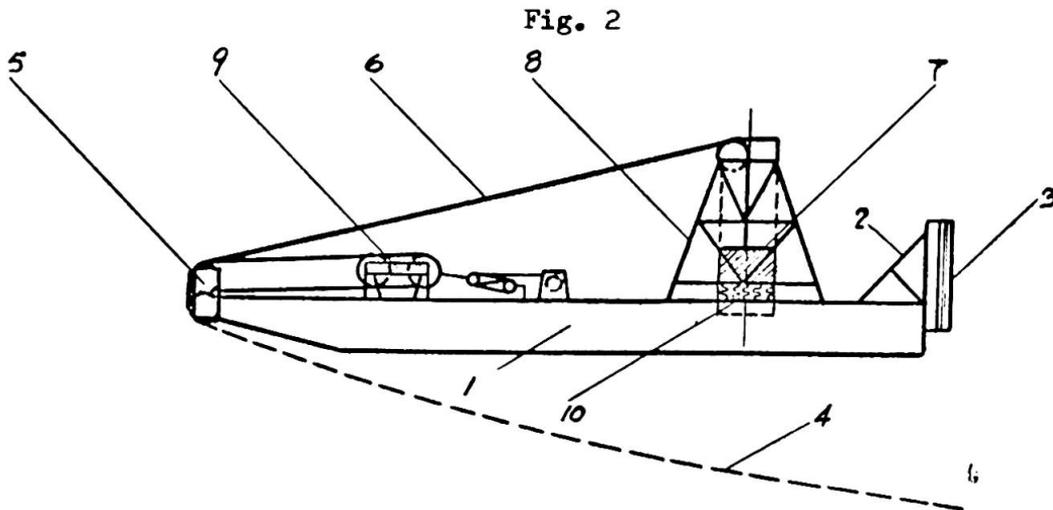
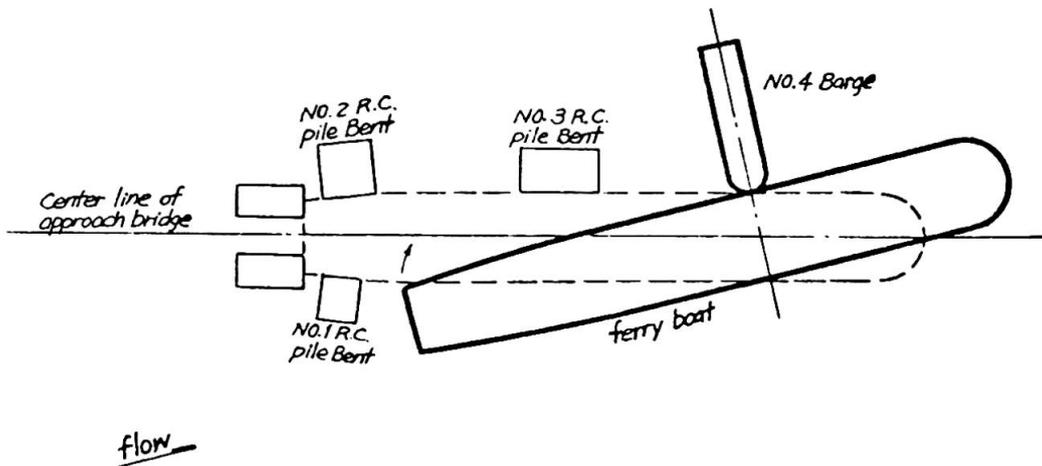


Fig. 1

of the bridge. No.3 Bent is so placed to keep the ferry boat in alignment with the center line of the bridge. No. 4 is a barge with two counterweights. The entire process of steering the ferry boat in shore is as follows (Fig.2). The ferry boat steers in shore in a slow speed at an angle about  $15^{\circ}$  with the centerline of the approach bridge. The ferry boat bumps against No.4 Barge. The hitting point is about  $\frac{2}{5}$  of the total length of the ferry boat measuring from the stern. The ferry boat swings shore-ward and its forepart inserts in between No.1 and No.2 Bent slowly. The function of No. 4 Barge is to absorb the energy while the ferry boat bumps against it during steering in shore and thus stops the ferry boat in a short instant. Together with the three bents, No.4 Barge stabilizes the ferry boat throughout the hauling operation of the train to or from the ferry boat. When the ferry boat leaves the shore for sailing, it is necessary to drive backward a little and to swing the forepart of the ferry boat away from the shore. No.4 Barge can also satisfy these requirements.

The barge as sketched in Fig.3 consists of three main parts:



- |                          |                    |
|--------------------------|--------------------|
| 1. steel hull            | 2. steel frame     |
| 3. steel shield          | 4. anchoring chain |
| 5. pulley block          | 6. steel wirerope  |
| 7. counterweight         | 8. steel tower     |
| 9. chain length adjuster | 10. spring bumpers |

Fig. 3

1. The hull of the barge. It is a steel scow, 8 meters in width, 2 meters in depth, and 25 meters in length. On its forepart, a steel frame with a steel shield is installed. The variable positions of the board caused by loading or unloading the ferry boat determines the height of the shield. The bumping force from the ferry boat hits directly onto the shield of the barge.

2. The anchoring device. There are three pairs of anchoring chains as sketched



in Fig. 4. Two reinforced concrete anchors are launched in front of the barge.

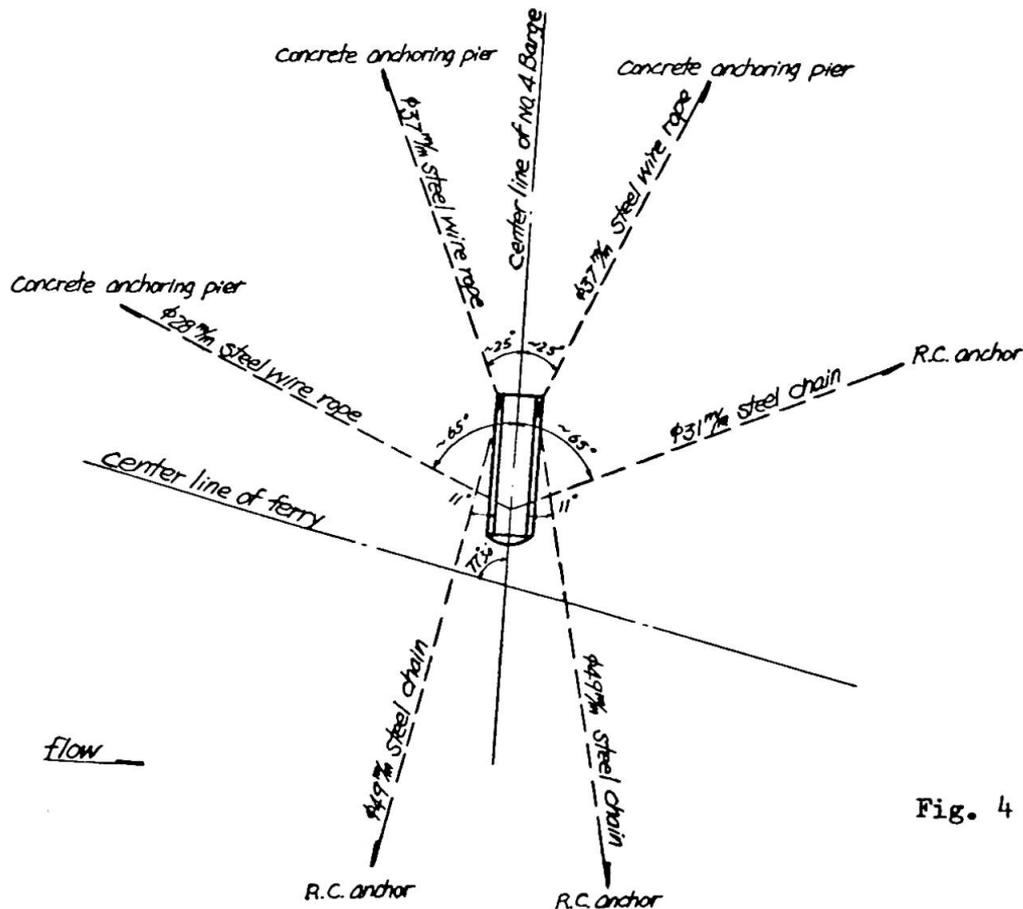


Fig. 4

Its steel chains, 49 millimeters in diameter, passing through pulley blocks at the stern of the barge are connected to two steel wire ropes. The ropes in turn passing through the pulley blocks on the top of the steel tower connect to the counterweights. When being pulled taut, the chains absorb part of the energy produced during steering the ferry boat in shore. When the energy exceeds that the chains can provide, the counterweights will then be hauled. Another pair of steel wire ropes 37 millimeters in diameter are fastened to the stern of the barge, and are anchored to the concrete anchoring piers on the shore. This pair of wire ropes keep the barge in its desired position, without them the barge would push the ferry boat away when the counterweights drop. The third pair is fastened on the front part of the barge. Toward the down-stream side a steel chain, 31 millimeters in diameter, is used with reinforced concrete anchor. Toward the upstream side is a steel wire rope 28 millimeters in diameter which is fastened to a concrete anchoring pier on the shore. These two resist the frictional force caused by the board of the ferry boat and the shield of the barge during operation.

3. The counterweights. Two counterweights each weighing 25 tons are used. They are guided by vertical channels of the steel tower. They can be lifted to a maximum height of 3 meters. When they are raised to the top of the tower, it requires an energy of 150 ton-meters. ( $E=2 \times 25^T \times 3^m = 150^{T-m}$ ). In another words, the counterweights can absorb an energy of  $150^{T-m}$  during steering the ferry boat in shore. The counterweights can also limit the stresses in the cables and chains, and limit the bumping force on the shield of the barge. Each cable or chain will not be loaded over  $25^T$  which is the weight of one counterweight. Neither will the shield be hit by a force over  $50^T$  which is the total weight of two counterweights. In this manner, the load acts upon the board of the ferry boat, the barge (including the hull, the chain, the shield, etc.) will all be limited within the designed load. Safety of these structures are thus ensured.

For each counterweight, an indicator is installed. The readings on the indicator tell the heights the counterweights being lifted. The designer limits the permissible height to 2 meters.

Besides the three main parts described above, a further device is used to adjust the length of the chains so as to keep the barge in its desired position in accordance with the variable water level in different seasons.

The design has been adopted in three railway ferries in China. Over twenty years in service, no accident causing traffic stoppage has ever occurred. This design, which has gained high approval, is characterized by the absence of heavy underwater work, high efficiency, guaranteed safety, good reliability, low cost and least maintenance.

The photo of the barge see Fig. 5.

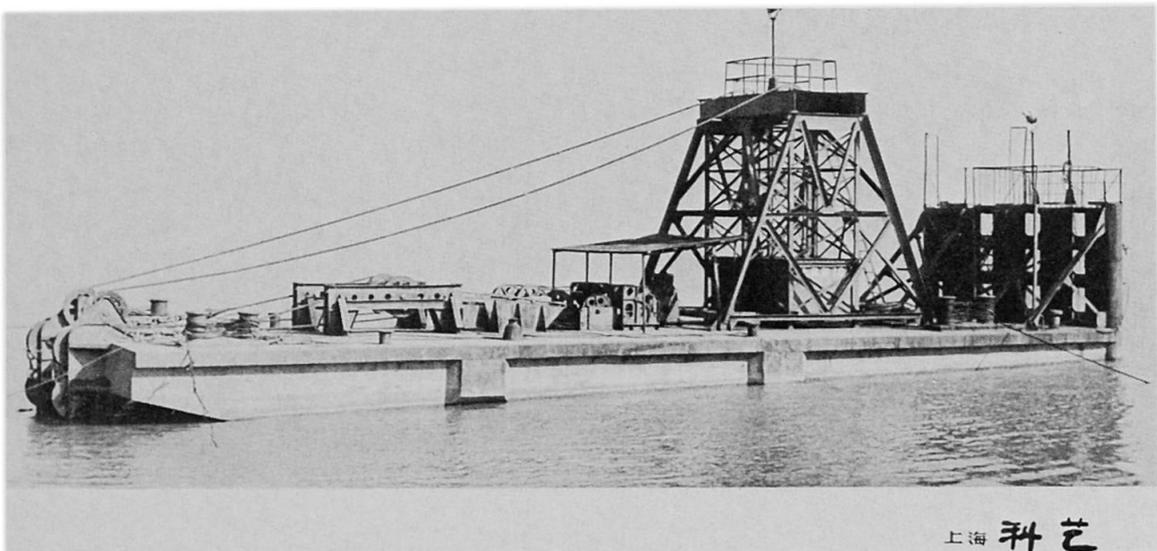


Fig. 5

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