United States Patent [19]

Ingram et al.

[11] **3,727,650**

[45] **Apr. 17, 1973**

[54] **TRANSFER ARRANGEMENTS**

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[52] **U.S. Cl.** **141/98,** 141/279, 141/388, 214/14

[51] **Int. Cl.** **B65b 3/04**

[58] **Field of Search** 104/114; 137/236; 141/279, 284, 382, 387, 388, 231–233, 98; 214/12, 13, 14

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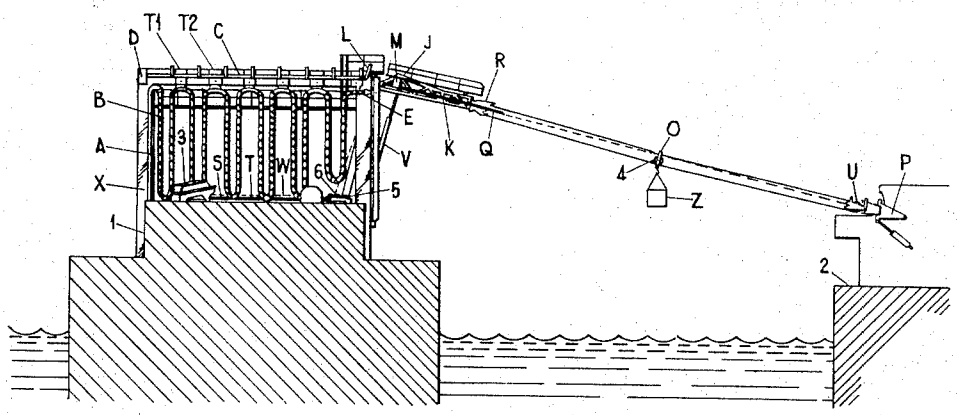
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[57] **ABSTRACT**

A transfer arrangement for transferring articles between two relatively moving stations such as ships under way in which a support cable extending between the stationsprovides a support for an article carrier, in which one of the stations carries a plurality of trolleys each supporting spaced regions of a flexible hose, and means are provided for feeding the trolleys on to the support cable until the leading trolley reaches the other station to permit the transfer of fluids between the stations, the movement of the intermediate trolleys being thereafter controlled in dependence upon variations in the distance between the stations to maintain a substantially uniform spacing between them.

12 Claims, 9 Drawing Figures



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SHEET 1 OF 3

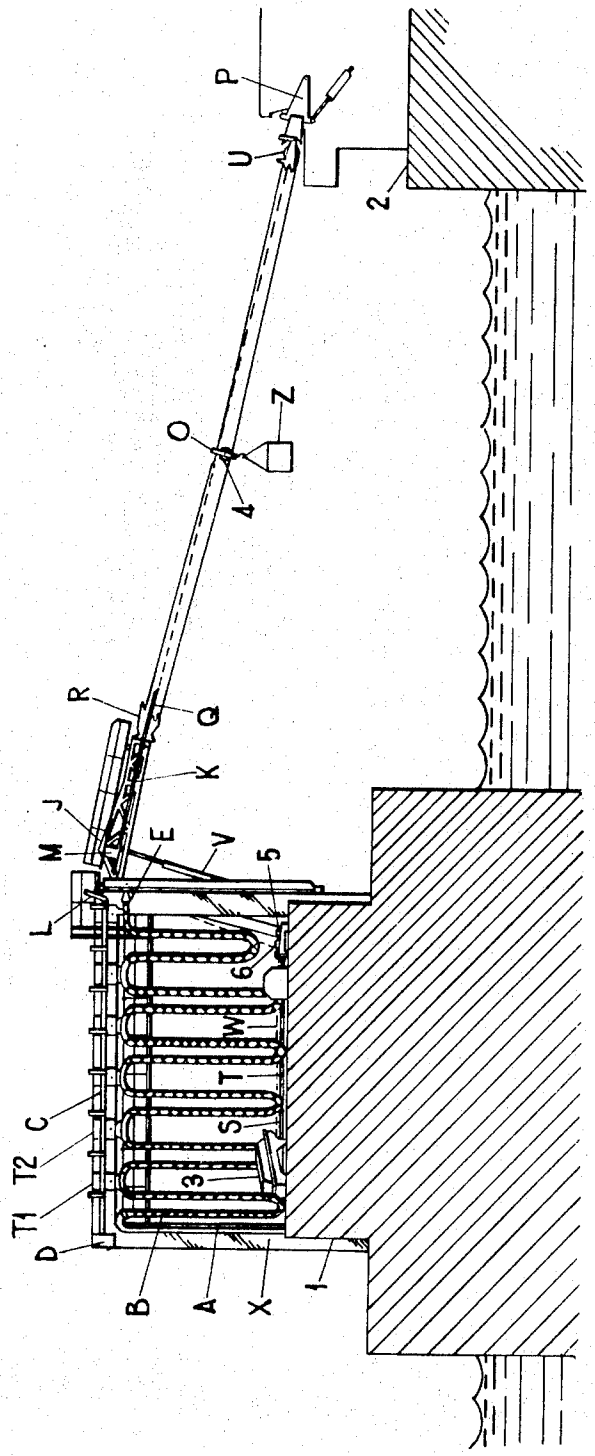


Fig. 1

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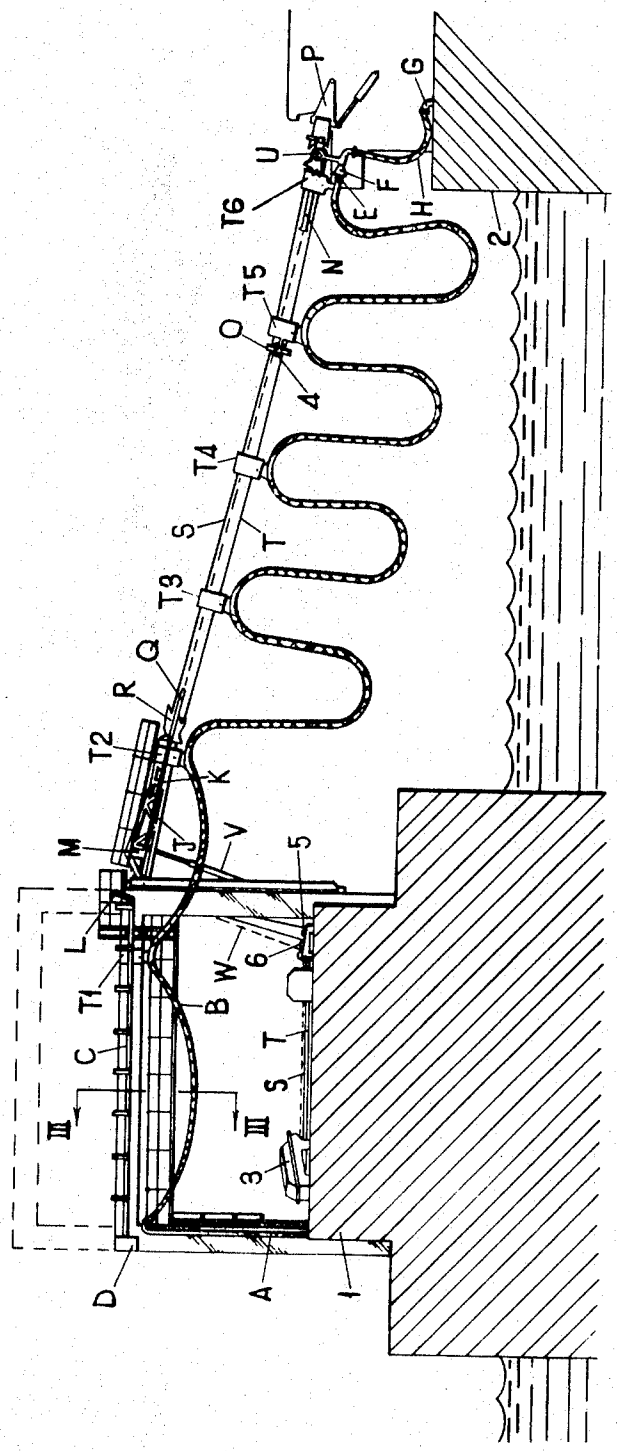


Fig. 2

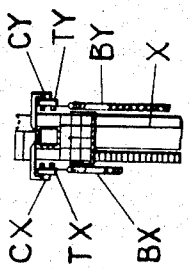


Fig. 3

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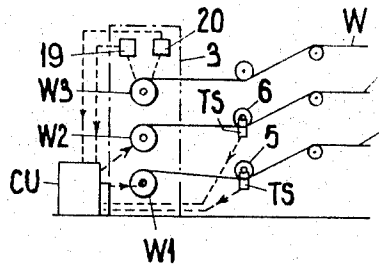


Fig.4

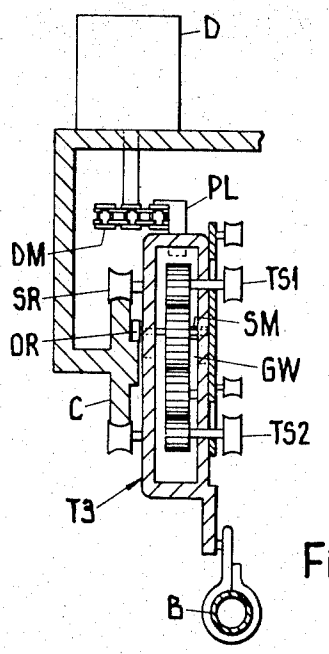


Fig.5

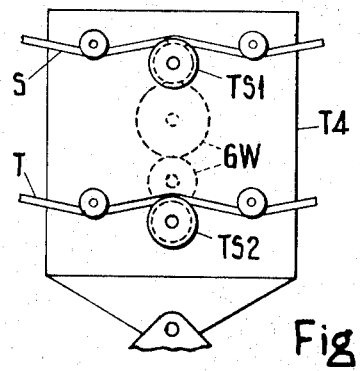
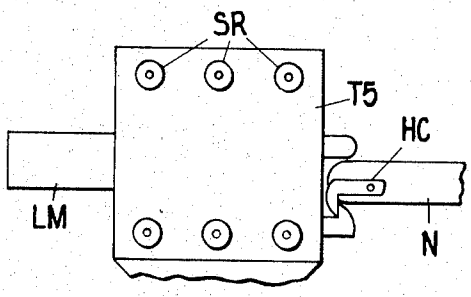


Fig.6



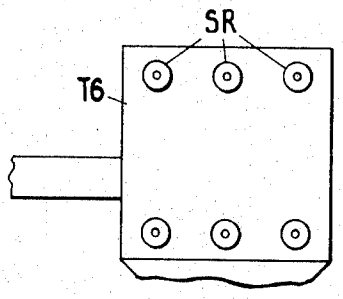


Fig.7

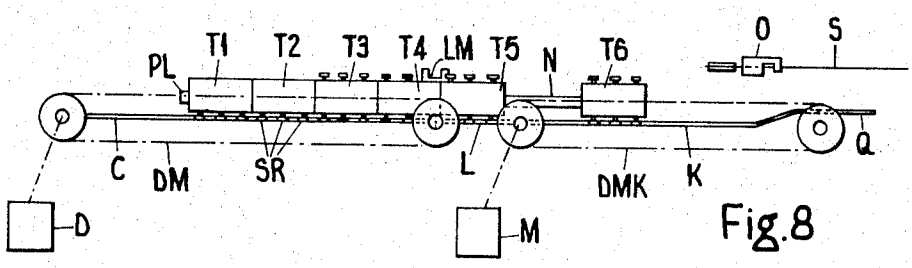


Fig.8

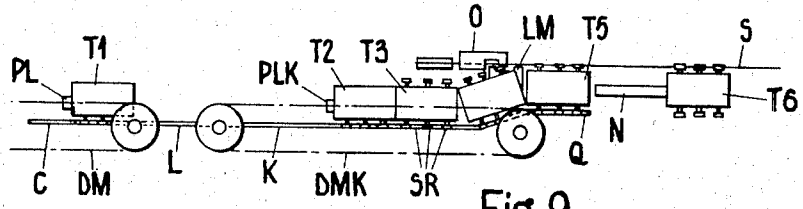


Fig.9

TRANSFER ARRANGEMENTS

This invention relates to arrangements for transferring articles between two stations which are capable of moving relatively from each other during such transfer so as to vary their distance apart, and which arrangements are of the kind incorporating a support cable carried by a winch on one of the stations and arranged to extend to a connecting member on the other station to provide a support for an article carrier which is movable across the cable between the two stations.

Transfer arrangements of this kind have application, for example, in the trans-shipment of cargo and stores between two ships at sea, and in an arrangement designed for such a purpose means may be provided for controlling the operation of the winch in a manner which causes the support cable to be paid-out or hauled-in automatically in dependence upon variations in the distance between the ships, in order to avoid excessive vertical oscillations of the load as it is being transferred; one such transfer arrangement forms the subject of the invention described in British Pat. Specification No. 1,185,771.

In some cases it may, however, also be required to pass a flexible hose between the two stations for enabling a fluid, for example furnace fuel oil, diesel oil, kerosene or water, to be transferred between them, and an object of the present invention is to provide a common transfer system which may be used for this purpose as well as for the transfer of solid articles.

According to the invention a transfer arrangement of the kind referred to, including means for controlling the operation of the winch to enable the support cable to be paid-out or hauled-in in dependence upon variations in the distance between the two stations, includes on said one station a support rail for a plurality of trolleys each arranged to support a respective one of a plurality of spaced regions of a flexible hose, means for driving at least some of the trolleys from the support rail to the support cable when the latter is connected between the two stations, means for feeding the leading trolley along the cable to said other station to carry an end of the hose thereto, and means for feeding trolleys supporting intermediate regions of the hose along the support cable at controlled rates to spaced positions along the cable.

Preferably a leading one of the trolleys is connectable to the article carrier, such that the traversal of the latter across the cable effects the feeding of this trolley along the cable, means being provided for feeding the following trolleys across the cable at appropriate proportions of the speed of the article carrier to effect the required spacing of the trolleys along the cable.

Conveniently the second trolley is connectable to the article carrier, and is arranged to push the leading trolley across the cable to said other station, the latter being provided with means for engaging and supporting the leading trolley, and the second trolley being subsequently withdrawable therefrom to a position on the support cable spaced from said other station. In such an arrangement the leading and second trolleys are conveniently capable of being releasably secured together to enable the leading trolley to be withdrawn across the support cable at the end of a transfer operation.

Control means are preferably associated with the winch for maintaining the second trolley at a distance from said other station which is a substantially constant

proportion of the total distance between the two stations, despite relative movement of the stations, whilst the hose extends between them, together with means for producing a movement of the trailing trolleys along the cable corresponding to changes in the distance of the second trolley from the other station by amounts such as to maintain an approximately uniform spacing of the trolleys along the cable.

This is conveniently achieved by the use of a support cable in the form of a loop with the two sections of the loop each carried by a respective winch drum on said one station, and the loop passing around a pulley on the other station, and the carrier member fixed into one of the two loop sections so that it can be traversed between the two stations by appropriate operation of the winch drums, the control means being operable to cause the winch drums to pay-out or haul-in the two sections of the cable as required, following the positioning of the second trolley, in order to maintain the trolley at a distance from the second station which is substantially a constant proportion of the total distance between the stations as aforesaid.

Then each of said trailing trolleys on the support cable may be provided with sheaves engageable with the two loop sections and geared together in such a manner that differential movement of the two loop sections to maintain the said second trolley at a required spacing from the second station on relative movement of the two stations, produces a corresponding movement of the respective trailing trolley along the cable, the gearing being selected for each of the trolleys such that a substantially uniform spacing is maintained between them.

Conveniently the transfer arrangement incorporates means for monitoring the distance between the two stations, and for deriving therefrom variable control signals, means for modifying said control signals in response to variations in the tension of the support cable, and means for controlling the operation of the support cable winch, and hence the effective length of the support cable, in response to said modified control signals so as to effect a damping of tension oscillations produced in the support cable due to a relative oscillatory movement of the two stations, as described in British Pat. Specification No. 1,185,771, the distance between the two stations preferably being monitored by means of a "distance cable", carried by a winch drum on the first station and arranged to be attached to a connecting member on the other station, and means being provided for maintaining a tension in the distance cable such that it extends substantially directly between the stations whereby any variation in the distance between the stations gives rise to an extension or reduction in the effective length of the distance cable.

At least the first station is preferably provided with a support arm capable of up-and-down pivoting movement from which the support cable is arranged to extend to the second station, the support arm conveniently carrying an auxiliary support rail on to which trolleys can be fed from the main support rail, and from which they can be fed on to the support cable. At least one trolley is conveniently retained by the main support rail, and at least one other by the auxiliary support rail, when the hose is extended between the two stations, in order to provide supports for regions of the hose at the end adjacent the first station.

The second station is conveniently also provided with a support arm which is capable of up-and-down movement, this support arm having associated with it means for securing the leading trolley thereto after the trolley has been traversed across the support cable and is conveniently constructed as described in U.S. Pat. No. 3,589,299 to David John Ingram dated June 29, 1971, to facilitate the loading and unloading of the article carrier during the trans-shipment of solid articles, and also to permit the attachment, to the arm, of a receiving unit for engaging a probe at the end of the flexible hose for the transfer of a liquid.

One transfer arrangement in accordance with the invention will now be described by way of example with reference to FIGS. 1 to 9 of the accompanying schematic drawings, in which:

FIGS. 1 and 2 represent the transfer arrangement in diagrammatic form in two different operating conditions, and

FIG. 3 represents a section of part of the arrangement across the line III—III of FIG. 2,

FIG. 4 illustrates another part of the arrangement in diagrammatic form,

FIG. 5 represents an enlarged transverse section of the part of the arrangement illustrated in FIG. 3,

FIG. 6 illustrates a side view of one of the trolleys employed in the arrangement,

FIG. 7 illustrates a side view of two further trolleys, and

FIGS. 8 and 9 show in diagrammatic form the operation of drive mechanisms for the trolleys.

In FIGS. 1 and 2 of the drawing 1 is a supply ship from which a liquid is required to be transferred to a receiving ship 2 while the two ships are travelling side-by-side on a substantially parallel course. The supply ship 1 carries a winch 3 having three drums W1, W2, W3 designed to be operated by fixed displacement motors geared directly to the respective drums. The lowest drum W1 carries one end of a length of cable T which is arranged to pass around a pulley U on the receiving ship 2 and is connected to an article carrier 0 supported by means of a pulley 4 on the lower section of the cable T. A further length of cable S has one end secured to the article carrier 0, and its opposite end carried by the middle winch drum W2. The article carrier 0 or traveller, as it will hereinafter be referred to, can therefore be traversed across the cable by appropriate operation of the winch drums and can therefore be used to carry articles of cargo and stores between the two ships as at Z in FIG. 1, the load being effectively shared by both the upper and lower sections of the loop (S, T) of cable.

The upper winch drum W3 carries a relatively light cable W arranged to be connected to a fixed point on the receiving ship, the tension in this cable being maintained substantially constant so that it extends approximately directly between the two ships. This winch drum has associated with it a tachometer generator 19 and a revolution counter 20 mounted so as to be responsive to the rotation of the drum when the distance between the ships varies, and arranged to feed signals to a control unit CU which controls the winch drums carrying the cables S, T.

In addition the tensions in these cables are continuously monitored by means of tension sensors TS associated with diverter pulleys 5, 6 around which the cables pass, and signals corresponding to these tensions are fed into the control system where they are compared with nominal tension signals to produce tension error signals, these latter being used to modify the signals used to control the cable pay-out or haul-in velocities of the winch drums carrying the cables S, T whereby fluctuations in the tensions of the latter, due to oscillatory variations in the distance between the ships, are effectively damped as described in British Pat. Specification No. 1,185,771.

In order to enable various fluid cargoes, for example furnace fuel oil, diesel oil, kerosene or water also to be transferred from the supply ship 1, to the receiving ship 2, the supply ship is provided with a pumping system capable of delivering a fluid requiring transfer to an appropriate one of a series of standpipes A to the top of each of which is connected a respective flexible hose B. Only one such standpipe and hose is illustrated in FIGS. 1 and 2 of the drawings for simplicity. Each of the flexible hoses B is supported on a series of trolleys numbered T1 to T6, and when the respective fluid transfer system is in the stowed position (FIG. 1) all of the trolleys are supported by rollers SR on a rail member C extending transverse to the ship and mounted on a supporting frame X. The rail member C is provided with an internal chain drive mechanism of any suitable kind illustrated at DM in FIGS. 5 and 8, and powered from a drive unit D. The flexible hose B is terminated with a probe unit E capable of connecting automatically in a fluid tight manner to a co-operating receiving unit F (FIG. 2). This in turn is arranged to be connected to the receiving ship intake point G by a short length of flexible hose H.

The supply ship 1 carries a pivoted arm J capable of being raised and lowered, and provided with an auxiliary rail member K at the side of the arm for the handling of the trolleys T1 to T6 as will subsequently be described. A bridge piece L is provided to connect the main rail C with the auxiliary rail K; the auxiliary rail K is also provided with an internal chain drive mechanism DMK similar to the drive mechanism DM and powered from a drive unit M. It will be seen that the leading trolley T6 is provided with an extended stop member N which projects towards the second trolley T5. The latter trolley is designed for attachment to the traveller 0 by an automatically operated latch mechanism LM as will subsequently be described.

When the system is in the stowed position, the stop N of the trolley T6 is in contact with the trolley T5 and the trolleys T4, T3, T2 and T1 are all spaced out across the main rail member C. When it is desired to bring the fluid transfer system into use, the receiver/connecting pipe assembly F and H are first transferred to the receiving ship making use of the article handling system. That is to say they are transferred to the receiving ship on the traveller 0. Upon arrival in the receiving ship, these items are secured to a further pivoted arm P on the receiving ship 2, which arm may be similar to the arm 32 of the arrangement illustrated in FIG. 1 of British Pat. Specification No. 1,185,771 or the arm 5 illustrated in FIG. 2 of U.S. Pat. No. 3,589,299 to David John Ingram dated June 29, 1971, the end of the hose H being coupled to the intake standpipe G. The traveller 0 is then returned to a stowed position at the end of the support arm J of the receiving ship.

Following this the pivoted arm J of the supply ship 1 is raised to its fully extended position, as shown on the drawing, by means of a hydraulic piston and cylinder unit V, and the bridge piece L is lowered to form a connecting path between the main rail C and the auxiliary rail K. The drive unit D is then started up and a push link PL on the chain drive DM causes all of the trolleys, except T1, to be transferred on to the auxiliary rail K. At this stage the stop N will still be in contact with trolley T5 and the remaining trolleys (apart from T1) will be spaced out on the auxiliary rail K.

In the next stage the drive unit M is started up and the trolleys are all driven forward by a push link PLK on the chain drive DMK towards the end section Q of the auxiliary support rail K. This section is so shaped in plan that as the trolleys pass beyond the end of a swinging head R at the extremity of the arm J they are transferred sideways to latch on to the carrying cables S and T. At this stage an operating roller OR on each trolley runs off the cam-like end Q of the auxiliary support rail K and a spring loaded mechanism SM inside each trolley is released in order to engage traction sheaves TS1, TS2 at the side of the trolley with the ropes S and T.

The trolley T6 is thus driven forward on to the cables S, T, by the trolley T5, the trolley T5 is driven on to cables by the trolley T4 and so on, the trolley T2 remaining on the auxiliary rail K as shown. The trolley T5 carries a projection providing the latching mechanism LM by which it is arranged to be latched automatically to the traveller 0 as it is passing the traveller (FIG. 9), which at this stage is positioned in the end of the swinging head R. Thus the trolley T5 will from that time onwards be driven by the traveller 0.

The trolleys T5 and T6 are themselves inherently free running on the cable system whereas the trolleys T3 and T4 are in effect "geared" trolleys, which means that the upper and lower traction sheaves TS1, TS2 (FIG. 5), which are operated respectively by the cables S and T, are geared together by means of gear wheels GW with a ratio which differs between the trolley T3 and the trolley T4. This is the means whereby the trolleys T3 and T4 are retained at the correct spacing to ensure an approximately even disposition of the trolleys T3, T4 and T5 irrespective of variation in ship side-to-side separation.

Since the trolley T5 is latched to the traveller 0 it will be seen that the control system can be used to position the trolley T5 at an appropriate distance from the receiving ship by appropriate operation of the winch drums associated with the cables S, T. Thus, the initial action of traversing the trolley T5 (by means of the traveller) results in the trolley T6 being pushed ahead of it making use of the extended stop N until the probe E engages and is connected to the receiver F. This operation is followed by the withdrawal of the trolley T5 to an appropriate distance from the receiving ship's side (FIG. 2), after which this distance will be maintained automatically at a value which is an approximately constant proportion of the total distance between the ships, irrespective of variation in ship side-to-side separation, by the control system which is similar to that described in British Pat. Specification No. 1,185,771. Thus it follows that the positioning of the trolley T5 in this manner gives rise to a differential movement between the cable S and the cable T as the ships move apart or together. Essentially this action is achieved because the junction point between the rope S and the rope T is at the traveller O which is positioned some distance from the terminal pulley U of the cable system. It is this differential movement which is used to actuate the geared trolleys T3 and T4 to maintain even spacing of the three trolleys within the distance between the two ships.

It will be seen from the drawing that the trolley T2 is of a different type and this unit never leaves the auxiliary rail K even when the ships are operating at the maximum separation distance. Similarly the trolley T1 never leaves the main rail C. As previously explained, for the initial rigging operations the pivoted arm J of the supply ship is in the fully raised position — achieved by extending the piston of the piston and cylinder unit V to its fullest extent. Once the system has been rigged, pressure in the cylinder of the unit V is reduced such that the arm assembly J and swinging head R can remain approximately in line with the line taken by the cable system S and T.

For unrigging the system, it is necessary to operate a hand release mechanism to enable the probe E to be disconnected from the receiver F. Advantage of this fact is therefore taken to provide a hand operated catch HC on the end of extended stop N of the trolley T6. Thus as a first step in the unrigging operation the trolley T5 is traversed across towards the receiving ship until it contacts the stop N. The probe unlatching operation just described is then undertaken, and at the same time the catch HC between the trolley T5 and the stop N is closed so that these two units are then connected together. It is now possible to traverse the traveller O back towards the supply ship during which movement the trolley T6 will be pulled in the supply ship direction with it. The trolleys T3 and T4 will, of course, move ahead of T5 at a relative velocity to the supply ship dictated by their respective gear ratios and the varying differential between the cables S and T. Thus the trolley T3 will enter the end Q of the auxiliary rail K first and will eventually contact the trolley T2 which will start to move in the direction of the bridge piece L. Similarly, the trolley T4 will next enter the end Q of the rail K, after which the traveller O will arrive back in the swinging head R where it will be engaged by the latter. At this point the trolley T5 will be automatically unlatched from the traveller and will be driven forward along rail K by the drive mechanism M. At this stage the trolley T6 is still attached to the trolley T5 and will remain so attached until the next transfer operation with the rig is required. At this stage therefore it only remains to operate the drives M and D until such time as the trolley T6 is again in its stowed position on the main rail C together with the remainder of the trolleys.

It will be appreciated that the support rails drive mechanisms, trolleys, hose and probe/receiver assemblies described above constitute an additional fluid handling assembly which can be added to the basic article transfer arrangements as described in British Specification No. 1,185,771 and U.S. Pat. No. 3,589,299 to David John Ingram dated June 29, 1971, so that in all other respects the operation, control and rigging/unrigging of the system may be substantially as disclosed therein. It will, however, be observed that,

because it is necessary for the position of the trolley T5 relative to the receiving ship to be a fixed percentage of the total distance between supply and receiving ships, in order to obtain the required differential motion of the upper and lower section of the support cable which is necessary to actuate trolleys T3 and T4, the signals which control the paying out or hauling in of the support cable in dependence upon the variation in the distance between the ships will need to be appropriately modified when the transfer arrangement is used in this manner, compared with those of the arrangements described in British Specification No. 1,185,771, in order to maintain the trolley T5 in the required relationship with the side of the receiving ship. Other forms of control systems might, however, alternatively be employed.

Conveniently a pair of flexible hoses BX, BY may be located one at each side of the frame X as shown in FIG. 3, each being connected to respective standpipes (not shown) and carried by its own set of trolleys TX, TY, supportable by respective rail member CX, CY in the stowed position. In such a case the pivoted arm J of the supply ship may be provided with a pair of auxiliary rails located one each side, each terminating in an end portion arranged to guide the trolleys on to the support cables S, T during a transfer operation involving a respective one of the hoses in the manner previously described. Alternatively, a second pivoted arm, also carrying an auxiliary rail, may be provided at the other side of the frame, one hose being associated with one arm, so as to be extendable from one side of the supply ship and the other hose being associated with the other arm so as to be extendable from the other side of the ship, so that fluid may be transferred to a receiving ship on either the port or the starboard side of the supply ship.

The supply ship 1 is conveniently provided with a plurality of frames X each associated with a pair of flexible hoses and located at suitable positions on the ship.

We claim:

1. A transfer arrangement for transferring articles between two stations which are capable of moving relatively to each other during such transfer so as to vary their distance apart, including an article carrier, a winch, a support cable carried by the winch on one of the two stations and extendable to a connecting member on the other station to provide a support for the article carrier, the article carrier being movable across the cable between the two stations, means for controlling the operation of the winch to enable the support cable to be paid-out or hauled-in in dependence upon variations in the distance between the two stations, a flexible hose, a plurality of trolleys each capable of supporting a respective one of a plurality of spaced regions of said flexible hose, there being provided on said one station a support rail for said plurality of trolleys, means for driving at least some of the trolleys from the support rail to the cable when the latter is connected between the two stations to enable the leading trolley to be fed along the cable to said other station to carry an end of the hose thereto, and means for feeding trailing trolleys supporting the intermediate regions of the hose along the support cable at controlled rates to spaced positions along the cable.

2. A transfer arrangement according to claim 1 wherein the second trolley incorporates means for engagement with the article carrier such that traversal of the latter across the cable effects the feeding of this trolley and the leading trolley along the cable, and the means for feeding said trailing trolleys along the cable comprises traction sheaves carried by the trolleys for engagement with the support cable, and gearing means controlling the rotation of the sheaves and selected for each of the trolleys to effect the required spacing of the trolleys along the cable.

3. A transfer arrangement according to claim 2 wherein the said other station is provided with means for engaging and supporting the leading trolley, and the second trolley being subsequently withdrawable from the leading trolley to a position on the support cable spaced from said other station.

4. A transfer arrangement according to claim 3 wherein catch means are provided for releasably securing together the leading and second trolleys to enable the leading trolley to be withdrawn across the support cable with the second trolley at the end of a transfer operation.

5. A transfer arrangement according to claim 3 including control means associated with the winch for maintaining the article carrier and hence the second trolley at a distance from said other station which is a substantially constant proportion of the total distance between the two stations, despite relative movement of the stations, whilst the hose extends between them, the gearing means of the trailing trolleys being such as to produce a movement of these trolleys along the support cable in response to changes in the distance of the second trolley from the other station by amounts such as to maintain an approximately uniform spacing of the trolleys along the cable.

6. A transfer arrangement according to claim 5 wherein the said winch is located on said one station and has a plurality of winch drums, the support cable is in the form of a loop with the two sections of the loop each carried by a respective one of the winch drums, the loop passing around a pulley on the other station, and the carrier member being fixed into one of the two loop sections so that it can be traversed between the two stations by appropriate operation of the winch drums, the control means being operable to cause the winch drums to pay-out or haul-in the two sections of the cable as required, following the positioning of the second trolley, in order to maintain the trolley at a distance from the second station which is substantially a constant proportion of the total distance between the stations.

7. A transfer arrangement according to claim 6 wherein each of said trailing trolleys on the support cable is provided with a pair of said traction sheaves each engageable with a respective one of the two loop sections, the gearing means coupling the pair of sheaves in such a manner that differential movement of the two loop sections to maintain the said second trolley at a required spacing from the second station on relative movement of the two stations produces said movement of the trolleys along the cable to maintain said approximately uniform spacing between them.

8. A transfer arrangement according to claim 1 wherein at least the said one station, is provided with a

support arm capable of up-and-down pivoting movement from which the support cable is arranged to extend to the second station, the support arm carrying an auxiliary support rail on to which trolleys can be fed on to the support cable.

9. A transfer arrangement according to claim 8 wherein at least one of the trolleys is retained by the main support rail, and at least one other by the auxiliary support rail when the hose is extended between the two stations, in order to provide supports for regions of the hose at the end adjacent the first station.

10. A transfer arrangement according to claim 8 wherein the second station is also provided with a support arm which is capable of up-and-down pivoting movement, the support cable being arranged to extend between the pivoted support arms of both stations, and the support arm of the second station has associated with it means for securing the leading trolley thereto after the trolley has been traversed across the support cable.

11. A supply ship carrying a flexible hose and means for feeding an end of the hose to another ship so that the hose extends between the ships, and for supporting the part of the hose between the ships, said means incorporating a winch, a support cable carried by the winch and arranged to extend to a connecting member on said other ship, means for controlling the operation of the winch to enable the support cable to be paid-out or hauled in in dependence upon variations in the distance between the ships, a support rail for a plurality of trolleys arranged to support a respective one of a plurality of spaced regions of said flexible hose, means for driving at least some of the trolleys from the support rail to the support cable when the latter is connected between the two ships, means for feeding the leading trolley along the cable to said other ship to carry an end of the hose thereto, and means for feeding trolleys supporting intermediate regions of the hose along the support cable at controlled rates to spaced positions along the cable.

12. A supply ship according to claim 11 including at least two flexible hoses capable of being fed to respective other ships lying on opposite sides of the supply ship and each associated with a respective feeding and supporting means.

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