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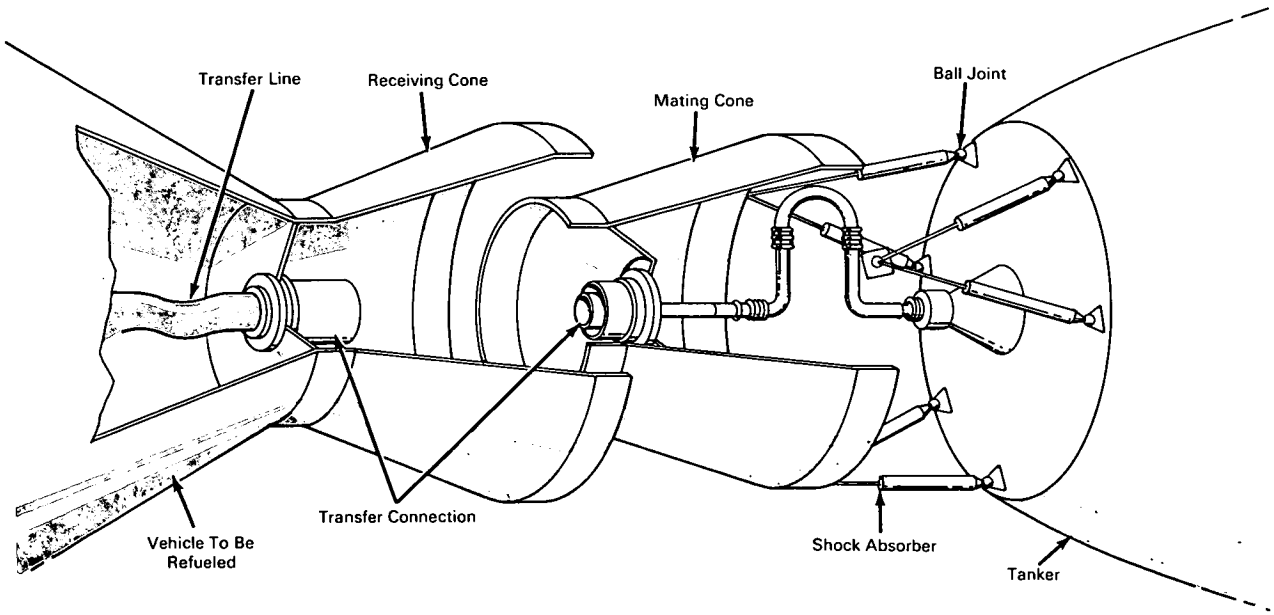
Fuel Transfer System Permits Rapid Coupling



The problem:

To provide a simple, yet efficient, method for transferring fuel from a tanker to another vehicle. Original interest in this problem arose through a requirement to connect an orbiting fuel tanker to a receiving spacecraft for the transfer of fuel. Methods exist, but are complex and many sequences of events are required to accomplish the connection and transfer.

The solution:

A docking and fuel transfer system which has these advantages over existing systems: (1) no triggering operation is required prior to docking; (2) the support system can be rigidized by simply locking the rams of shock absorbers; and (3) no separate fuel line coupling action is required.

How it's done:

The docking or connecting mechanism, shown in the figure, consists of a receiver cone mounted to the vehicle to be fueled, and a mating cone mounted on the tanker vehicle by shock absorbers. Six shock absorbers are arranged in sets of two, spaced 120° apart in a triangular pattern. The end connections of the shock absorbers are equipped with ball joints. The shock absorbers are two stage with a low spring rate over part of the stroke and a higher spring rate over the remainder of the stroke. One part of the fuel transfer connector is mounted on the receiver cone, the other section on the mating cone. A flexible fuel transfer line allows transfer of the fuel from one vehicle to the other.

(continued overleaf)

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The initial engagement of the mating cone with the receiving cone is permitted by the low spring portion of the shock absorber stroke and the multiplane freedom of motion allowed by the ball joints. The short cylindrical ends on the two cones provide for alignment of the parts of the fuel line connector just prior to their engagement.

The major portion of the impact energy of the two vehicles is now absorbed in the higher spring rate portion of the shock absorber. The controlled rebound of the shock absorbers returns the ram to its original length with small energy return to the vehicle and tanker. The two are now axially aligned due to the symmetrical arrangement of the shock absorbers. Additional rigidity to the support system is achieved by locking the rams of the shock absorbers.

The two vehicles are now docked and in position for fuel transfer.

The fuel transfer connection consists of that part of the mating cone and that part of the receiving vehicle which unite for transferring the fuel.

The receiving section is composed of the flange of the cone, the probe, and springs to permit alignment of the probe. The tanker or mating section consists of a collar (which is located to the left prior to engagement), a plunger, and locking balls. A ball screw jack is secured to the body, which is secured to the flange of the mating cone. A motor, mounted also on the flange, engages with the gear of the screw jack. Three pneumatic bellows are evenly spaced around the connector. A feed line is interconnected between the bellows to insure their even pressure.

During docking, as the mating cone enters the receiving cone, the probe enters the body. The springs keep the probe centered and permit self-alignment of the probe with the body. As the probe enters, it depresses the plunger, and releases the balls. This permits the collar to move to the right, thus trapping the balls and locking the two parts of the connector together. The motor then operates the screw jack, which attaches the mating and receiving cones more firmly together with the forces being transmitted through the balls. Fuel is then transferred.

To release the two sections, the motor first releases the jacking forces. Pressure is then supplied to a bellows which moves the collar to the left, permitting the balls to disengage the probe. The cones, together with the connector, are now free to separate.

Notes:

1. This device could be adapted to fuel and liquid transfer applications in industry where large amounts of fuel must be transferred quickly.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B68-10039

Patent status:

No patent action is contemplated by NASA.

Source: Andrew M. West
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