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ONE-WAY DETONATION TRANSFER DEVICE AND ASSEMBLY

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Fig. 1

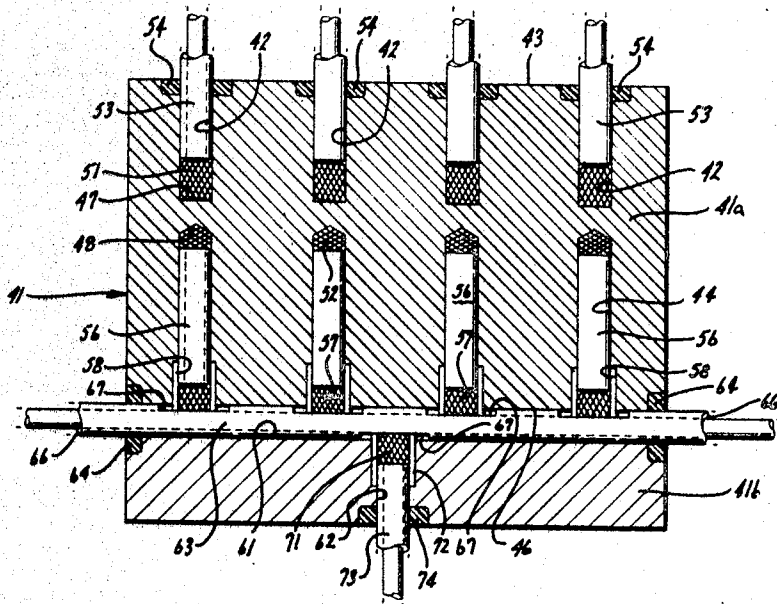
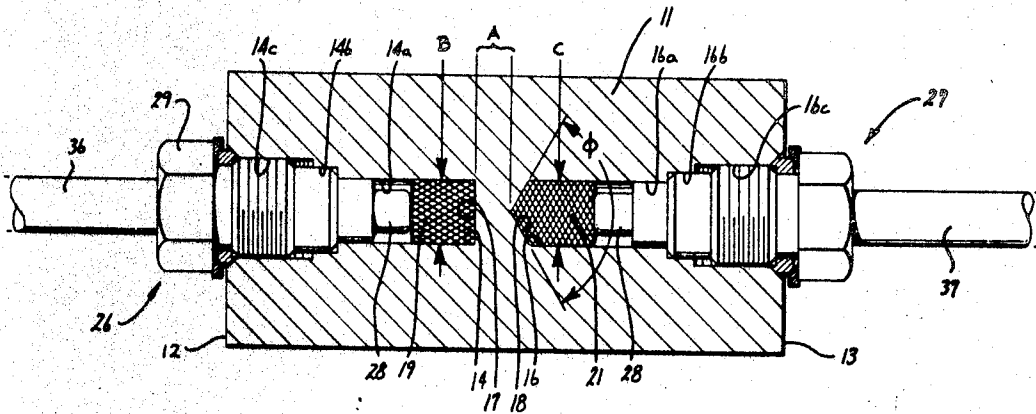


Fig. 2

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ONE-WAY DETONATION TRANSFER DEVICE AND ASSEMBLY

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8 Claims

ABSTRACT OF THE DISCLOSURE

One-way detonation transfer device and assembly having a flat or planar end wall for the donor charge and an angled end wall for the acceptor charge whereby shock waves from detonation of the donor charge converge along a line within the acceptor charge to initiate the acceptor charge and whereby shock waves from detonation of the acceptor charge are dissipated outwardly so that the donor charge is not detonated.

Background of the invention

One-way explosive transfer devices have heretofore been provided in which an explosion will propagate in one direction but will fail to propagate in the opposite direction. However, in general, such devices have disadvantages. Typically, they require great bulk to enclose and maintain the spacial relationships required. Their functional reliability depends upon the quantity of explosive utilized and they, therefore, employ quantities of explosive that are not practicably containable. Their reliability for not functioning in the reverse direction is predicted upon numerous factors which are not as controllable as they should be to obtain the desired reliability. There is, therefore, a need for a new and improved one-way detonation transfer device and assembly utilizing the same which will overcome the above named disadvantages.

Summary of the invention and objects

The one-way detonation transfer device is utilized for controlling the initiation of detonating cord from one or more preselected inputs and consists of a solid body. The body is provided with first and second axially aligned bores which face each other which are separated from each other by a portion of said body which is substantially non-compressible. One of the bores is provided with a flat end wall, whereas the other of the bores is provided with an angled or conically shaped end wall. The bore which is provided with the flat end wall receives the donor charge, whereas the one which has the conical end wall is provided with an acceptor charge. The conical end wall causes shock waves created by the detonation of the donor charge to converge along a line within the acceptor charge to initiate the acceptor charge. Conversely, when the acceptor charge is detonated, the conical end wall causes divergence or outward spreading of the shock waves so that the donor charge is not detonated.

In general, it is an object of the present invention to provide a one-way detonation transfer device and assembly in which the direction of propagation can be reliably controlled.

Another object of the invention is to provide a device and assembly of the above character which is relatively small, compact and light-weight.

Another object of the invention is to provide a device and assembly of the above character in which the products of detonation and fragments can be readily contained.

Another object of the invention is to provide a device and assembly of the above character which utilizes minimal quantities of explosive.

Another object of the invention is to provide a device and assembly of the above character in which the one-way detonation transfer can be accomplished with great reliability.

Another object of the invention is to provide a device and assembly of the above character in which explosive materials can be utilized which have minimal sensitivity.

Additional objects and features of the invention will appear from the following description in which the preferred embodiments are set forth in detail in conjunction with the accompanying drawing.

Brief description of the drawing

FIGURE 1 is a cross-sectional view of a device incorporating the present invention.

FIGURE 2 is a cross-sectional view of an assembly incorporating the present invention.

Description of the preferred embodiments

The one-way detonation transfer device shown in FIGURE 1 consists of a body 11 formed of a suitable solid material such as stainless steel or aluminum and which can have any desired configuration such as rectangular. The body is provided with planar end walls 12 and 13. The body is provided with a first bore 14 and a second bore 16 which are axially aligned and have their innermost ends facing each other. The bore 14 is provided with portions 14a, a slightly enlarged portion 14b and a threaded portion 14c. Similarly, the bore 16 is provided with a portion 16a, a slightly larger portion 16b and a threaded portion 16c. The innermost end of the bore 14 is formed by a flat or planar surface or end wall 17 which is perpendicular to the longitudinal axis of the bore 14. The end wall of the bore 16 is formed by a conically shaped surface or end wall 18 which converges in a direction towards the wall 17 of the bore 14 but is separated therefrom by a portion of the body 11 that has a depth which is indicated by the dimension A. This portion of the body is substantially non-compressible. The apex of the conically shaped surface or wall 18 is in alignment with the longitudinal axis of the bore 16 and with the longitudinal axis of the bore 14. A donor charge 19 of a suitable explosive is disposed within the bore 14 and fills the innermost end of the bore. Similarly, an acceptor charge 21 is disposed within the innermost end of the bore 16.

Connector assemblies 26 and 27 are threaded into the bores 14 and 16 and are of a conventional construction. Each of these connector assemblies is provided with a cap 28 which is in engagement with the associated charge in the bore. Each of the connector assemblies is also provided with a nut 29 which engages a washer 31 to hold a retaining ring 32 in place to ensure that particles of detonation will not pass from the body. Lengths 36 and 37 of detonating cord are connected into the connector assemblies 26 and 27.

Operation of the device shown in FIGURE 1 may now be briefly described as follows. Let it be assumed that the length of detonating cord 36 has been detonated by suitable means and that the detonation is carried into the connector assembly 26 to detonate the cap 28 within the bore 14. Detonation of the cap 28 causes detonation of the donor charge 19 within the bore 14. The construction of the connector assembly 26 in the body 11 is such that the products of the explosion are contained within the body.

Upon detonation of the donor charge 19, explosively produced shock waves are impulsively introduced into the essentially homogeneous media formed by the body 11

so that they will travel in a well-defined and predictable path. The shock waves either dissipate their energy within the body 11 as a function of the impedance of the media through which they are travelling, or until they encounter an interface between two different types of materials so that a juncture is made with a media of different shock impedance characteristics. When the shock wave encounters such a junction, it reacts in accordance with precise laws of hydrodynamics which are determined generally by the impedance of the associated media and the geometry or contour of the interface junction and other factors associated with the characteristics of the advancing shock front. In view of the fact that the surface 17 is perpendicular to the bore 14, the shock wave produced by the explosion of the donor charge 19 is propagated in a direction that is substantially normal to the surface 17 in a direction towards the acceptor charge 21 within the bore 16. Thus, with the device shown in FIGURE 1, the shock waves will travel in a direction toward the acceptor charge 21. However, upon encountering the angled surface of the conically shaped end wall 18, the shock wave is again transferred in a direction perpendicular or normal to the conical surface 18 in a direction towards the surface of the acceptor charge 21 so that the shock waves are directed inwardly to converge in a line in axial alignment with the bore 16 and within the acceptor charge 21 to detonate the same. This converging of the shock wave within the acceptor charge 21 manifests itself by an extreme concentration of energy that is sufficient to initiate the explosive which forms the acceptor charge. Because of this extreme concentration of energy from the donor charge, it is possible to form the acceptor charge of an explosive having either minimal sensitivity or a sensitivity such that it might not be initiated by a plane shock wave. Thus, it can be seen that in the present device, the shock waves are amplified or augmented to cause detonation of the acceptor charge. Because of this concentration of the shock energy, it is possible to reduce the quantity of explosive which is used in the donor charge or to separate the donor and acceptor charges by a greater and less easily ruptured barrier or bulkhead. As soon as the acceptor charge 16 is detonated, the cap 28 for the connector assembly 27 is detonated to detonate the length of cord 37.

Now let it be assumed that the cord 37 has been detonated and that the cap 28 is detonated which, in turn, detonates the acceptor charge 16. When the shock wave created by the detonation of the acceptor charge 16 encounters the conically shaped surface 18, the shock wave then travels in a direction which is normal or perpendicular to the surfaces of the conically shaped surface 18 to thereby cause the shock wave to diverge or to be dissipated outwardly and forwardly so that the donor charge is not detonated. Because of this spatial distribution of the shock wave created by the detonation of the acceptor charge 21, it can be seen that the device provides a very reliable one-way detonation transfer. Also, because of the construction, it is possible to place donor and acceptor charges in close proximity and to still maintain the overall reliability of performance for the device.

In the manufacture of the device shown in FIGURE 1, certain characteristics of the device are more critical than others. For example, the angle ϕ , which is the angle subtended by the conically shaped surface 18, can range from 90° to 160°. However, it has been found that the optimum angle is close to 132°. In general, it has been found that diameter B which is the diameter of the bore 14 should be equal to the diameter C which is the diameter of the bore 16. In the preferred embodiment, the ratio of diameter B to diameter C should be greater than unity and the dimension A, in turn, should be equal to the diameter C.

The type of explosive, the quantity of explosive and the pressure with which the explosive is compacted into the cavity or bore has a bearing on performance. It is

desirable that the donor charge be of a meta-stable chemical composition that will react at a rate sufficient to generate a shock wave when properly initiated and that the acceptor charge be of a meta-stable chemical composition capable of being initiated by the energy of an explosive generated shock wave. Typically secondary explosive compounds such as RDX, PETN, Dipam, HNS and HMX may be employed.

By way of example, in one embodiment of the invention, the donor charge is comprised of 40 mg. RDX compacted to 10,000 p.s.i. and having a diameter of 0.120 inch. The acceptor charge was formed of 10 mg. RDX compacted at 6000 p.s.i., 0.120 inch in diameter. The angle ϕ had an angle of 132°. The barrier dimension A had a dimension of 0.12 inch. The body 11 was formed of type 303 stainless steel.

In FIGURE 2, there is shown an assembly incorporating the present invention. It consists of a body or manifold housing 41 which is also formed of a suitable material such as stainless steel. The body 41 is formed of two parts or sections, 41a and 41b, which are fastened together in a suitable manner. The body 41 is provided with a plurality of bores 42 which are parallel to each other and which enter into the body section 41a through a face 43. The body is also provided with a plurality of additional bores 44 which extend into the body section 41a through the face 46. As can be seen from the drawing, a bore 42 is provided for each of the bores 44 so that the bores 42 and 44 form a plurality of pairs of axially aligned bores. The bores 42 terminate with a flat or planar end wall 47, whereas the bores 44 terminate with a conically shaped end wall 48. The faces 47 and 48 face each other but are separated by a portion of the body which serves as a bulkhead as hereinbefore described. A donor charge 51 is mounted in the innermost portion of each of the bores 42 and is formed of a suitable material of a type hereinbefore described. Similarly, an acceptor charge 52 is mounted in the innermost portion of each of the bores 44. The donor charges 51 are adapted to be initiated by pieces 53 of detonation cord which have one end inserted into the bore 42 and which are secured in the body by an epoxy ring 54. The detonation cord can be of a suitable type such as detonation cord marketed by Explosive Technology, Inc., under the trademark "X-CORD (RL-2-X)." This cord has a protective covering over a lead sheath.

Additional lengths 56 of the same detonation cord are provided within the bores 44 adjacent the acceptor charges 52 and serve to provide a suitable time delay as, for example, a 4 millisecond time delay. Booster charges 57 are mounted in each of the bores 44 at the end of the lengths 56 and within sleeves 58 fitted in the ends of the bores 44.

The body section 41b is provided with an elongate bore 61 which extends completely therethrough and an additional bore 62 which extends through the body section 41b in a direction at right angles to the bore 61. A long length 63 of detonation cord is mounted in the elongate bore 61 and extends through the bore and is fastened therein by epoxy rings 64. As can be seen from FIGURE 2, the outer protective sheath 66 of the cord has been cut away to provide recesses 67 so that the booster charges 57 contained within the sleeves 58 can come in direct contact with the inner portion of the detonation cord 63. The booster charge 71 mounted within a sleeve 72 is provided in the bore 62 and is seated in another recess 67 in the detonation cord 63. A piece of detonation cord 73 is mounted in the bore 62 and is retained therein by an epoxy ring 74.

Operation of the assembly shown in FIGURE 2 may now be briefly described as follows. The pieces 53 of detonation cord serve as four input charges which are adapted to be initiated externally which can cause initiation of the acceptor charges 51 where initiation of the acceptor charges 51 will cause the initiation of the booster

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charges 52 through the bulkhead formed by portions of the body 41 separating the donor and acceptor charges in a manner hereinbefore described in conjunction with FIGURE 1. Initiation of the acceptor charges 52 will cause initiation of the associated time delay 56 which, after the time delay, will initiate the booster charge 57. Initiation of the booster charge will cause initiation of the cord 63. Thus, it can be seen that the cord 63 can be initiated by initiation of any one of the input charges 53. Initiation of the cord 63 will cause propagation in both directions so that the cord can be utilized for initiation of two separation charges remotely located from the manifold or body 41. Initiation of the cord 63 will also cause initiation of the booster charge 71 to detonate the output cord 73 which can be utilized for detonation of another charge remotely located from the body 41.

From the foregoing, it can be seen that an assembly has been provided which has great redundancy for initiation of the cord 63 by which a plurality of outputs can be initiated from a single input charge. The assembly still has all of the one-way transfer characteristics of the device shown in FIGURE 1 in that initiation of an acceptor charge 52 will not cause initiation of a donor charge 51. For this reason, there is only a one-way transfer through the assembly. Each of the donor charges 51 with the associated acceptor charge 52 with the bulkhead provided between the same is analogous to a diode in that transfer can only occur in one direction through the same.

From the foregoing, it is apparent that there has been provided a one-way detonation transfer device and assembly which has many advantages. The relationship of the donor and acceptor charges within the body or housing is such that the donor may initiate the acceptor by the mechanism of shock wave transfer through the media of the housing but, conversely, the shock wave propagated by initiation of the acceptor charge is dissipated within the body or housing and is incapable of initiating the donor charge. Thus, it can be seen that the direction of propagation of detonation of a train of explosive components may be readily controlled. The body is constructed in such a manner that fragments or products of detonation are not liberated to the atmosphere. In other words, they are contained within the body and yet the body can be relatively small in size. Because of the unique characteristics of the construction utilized for the acceptor and donor charges, a minimal quantity of explosives is required, and at the same time it is possible to use explosive materials which have minimal sensitivity. In addition, the device and assembly incorporating the present invention provide great reliability and still can be provided in a body which has minimum envelope dimensions and minimal weight.

We claim:

1. In a one-way detonation transfer device, a body, said body having first and second bores therein, at least the innermost extremities of the first and second bores being axially aligned, the innermost extremities of said first and second bores being spaced from each other and being separated from each other by a portion of said body, said portion of said body being substantially non-compressible, the first of said bores terminating with a flat end wall and the second of said bores terminating with an end wall, at least a portion of which is inclined at a substantial angle with respect to the flat end wall of the first bore and the longitudinal axis of the axially aligned innermost extremities of the bores, a donor charge

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disposed in said first bore in close proximity to the flat end wall and an acceptor charge formed essentially of a secondary explosive compound disposed in said second bore and in direct and immediate contact with the inclined end wall, the inclined end wall of the second bore serving to cause shock waves created by detonation of the donor charge to converge along a line within the acceptor charge to initiate the acceptor charge and to cause shock waves created by the detonation of the acceptor charge to diverge so that the donor charge is not initiated upon initiation of the acceptor charge.

2. A device as in claim 1 together with means mounted in said first bore for detonating the donor charge and means mounted in the second bore and adapted to be detonated upon detonation of the acceptor charge.

3. A device as in claim 1 wherein said angled wall is symmetrical about the longitudinal axis of the second bore.

4. A device as in claim 3 wherein said angled surface is conical in shape.

5. A device as in claim 1 together with a length of detonating cord mounted in said first bore and a length of detonating cord mounted in said second bore.

6. In a one-way detonation transfer assembly, a body, a length of detonation cord disposed in the body, a plurality of pairs of first and second bores mounted in said body, the first and second bore of each pair being axially aligned but having their end walls separated from each other by a portion of said body, said portion of said body being substantially non-compressible, the first bore of each pair having a flat end wall substantially perpendicular to the longitudinal axis of the first bore and the second bore of each pair having an end wall which extends at a substantial angle with respect to the longitudinal axis of the bore and with respect to the flat end wall of the first bore, a donor charge disposed in the first bore of each pair, a length of detonation cord disposed in the first bore of each pair, means formed essentially of a secondary explosive compound mounted in the second bore of each pair in direct and intimate contact with said end wall of the second bore and also in relatively close proximity to the first named detonation cord mounted in said body whereby said first named length of detonation cord mounted in said body can be detonated by detonation of any one of said lengths of material in said first bores.

7. An assembly as in claim 6 wherein said end wall of said second bore of each of said pairs is generally conical in shape.

8. An assembly as in claim 6 wherein said means mounted in the second bore of each pair includes a time delay element.

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