Sept. 2, 1969 B. H. SMITH 3,464,311

DUAL PUNCH ASSEMBLY FOR CONSOLIDATING DELAY AND FUSE COMBUSTIBLE MATERIAL

Filed April 12, 1968 3 Sheets-Sheet 1

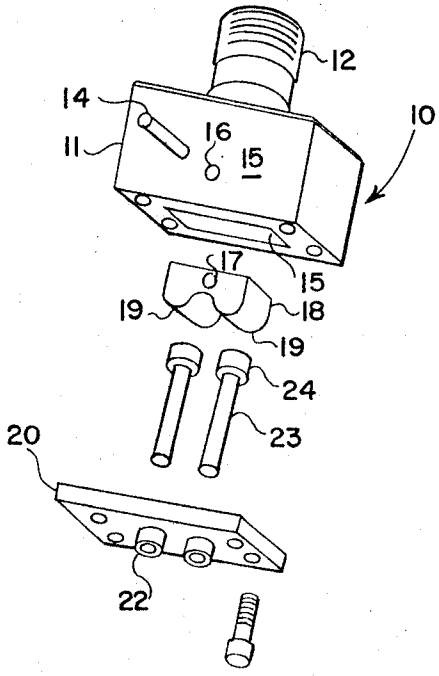


Fig. 1

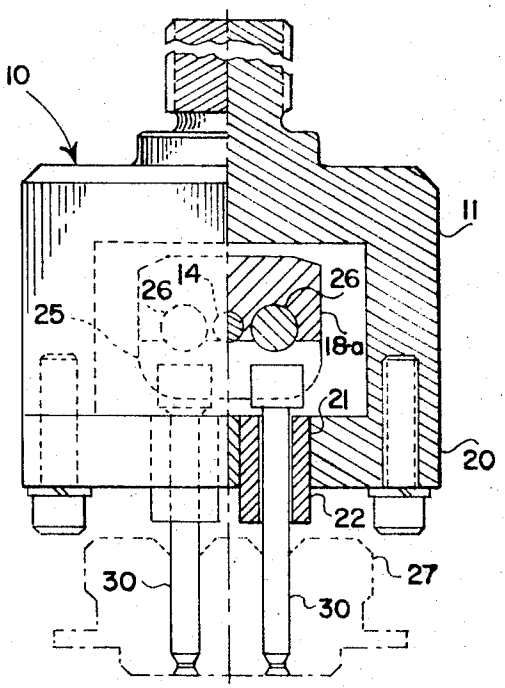


Fig. 2

INVENTOR.
Boyd H. Smith
BY
Thomas W. Brannon

Sept. 2, 1969 B. H. SMITH 3,464,311
DUAL PUNCH ASSEMBLY FOR CONSOLIDATING DELAY
AND FUSE COMBUSTIBLE MATERIAL
Filed April 12, 1968 3 Sheets-Sheet 2

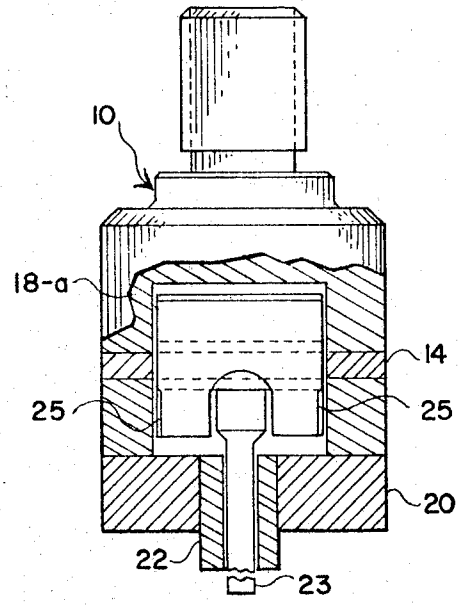


Fig.3

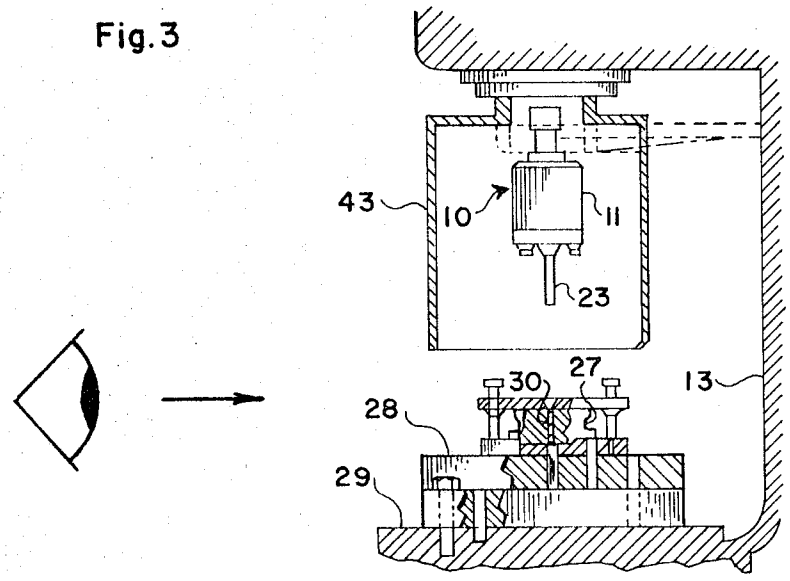


Fig.4

INVENTOR.
Boyd H. Smith
BY
Thomas W. Brennan

Sept. 2, 1969 B. H. SMITH 3,464,311

DUAL PUNCH ASSEMBLY FOR CONSOLIDATING DELAY AND FUSE COMBUSTIBLE MATERIAL

Filed April 12, 1968 3 Sheets-Sheet 3

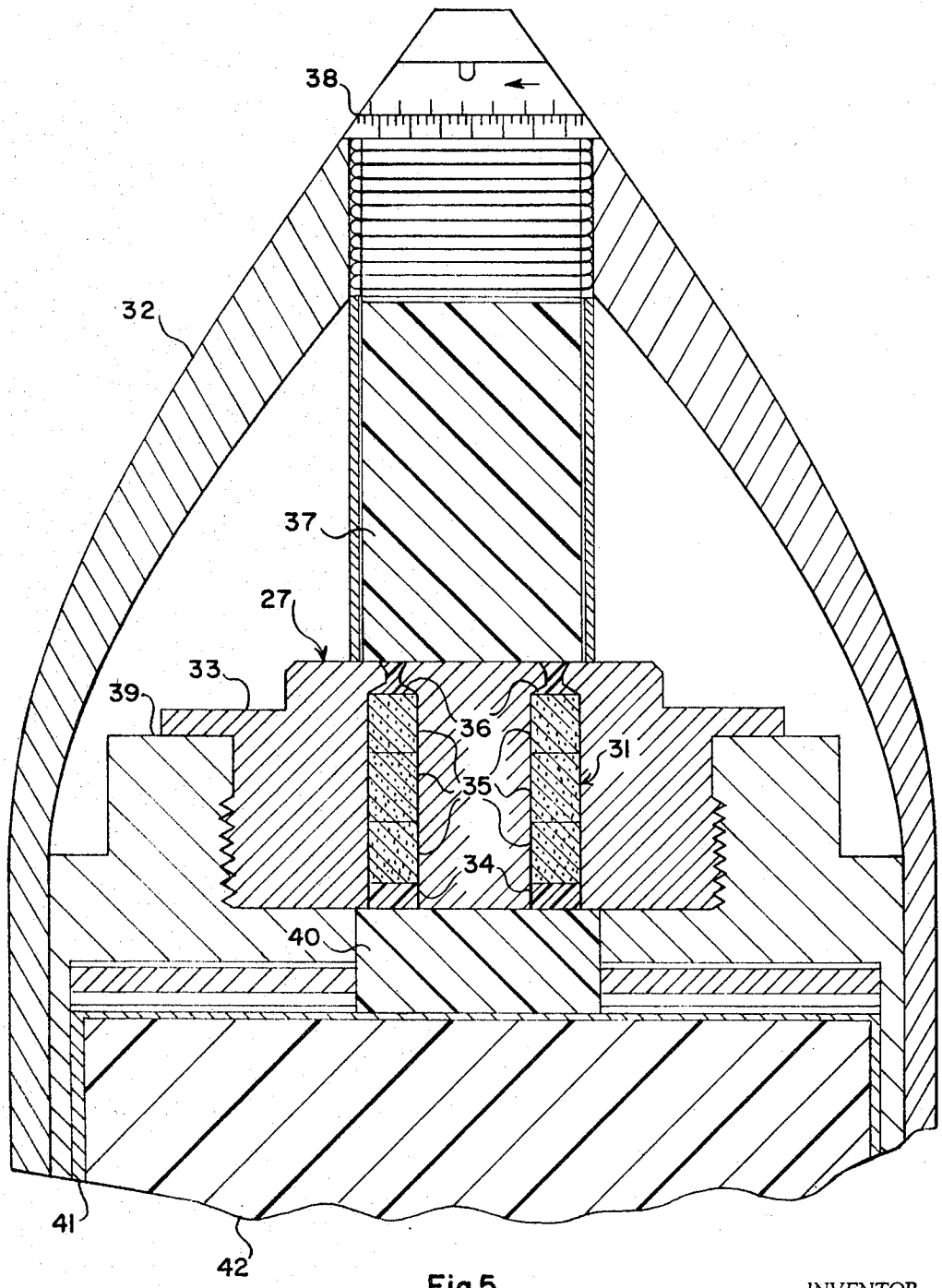


Fig.5

INVENTOR.
Boyd H. Smith

BY Thomas M. Brennan

United States Patent Office 3,464,311 Patented Sept. 2, 1969

3,464,311

DUAL PUNCH ASSEMBLY FOR CONSOLIDATING DELAY AND FUSE COMBUSTIBLE MATERIAL

Boyd H. Smith, Marshall, Tex., assignor to Thiokol Chemical Corporation, Bristol, Pa., a corporation of Delaware

Filed Apr. 12, 1968, Ser. No. 721,027
Int. Cl. F42b 33/00, 33/02
U.S. Cl. 86—1 4 Claims

ABSTRACT OF THE DISCLOSURE

A punch assembly adaptable to be driven by a punch press for consolidating combustible material in powder train delay fuses and the like is disclosed. The punch assembly includes a housing with a pivot bar swivelably mounted therein which contacts a pair of free floating punches. The punches thus transmit predetermined compacting, or consolidating loads to the material in the delay or fuse.

SPECIFICATION

This invention relates to loose material compacting, or consolidation devices and to devices of that character which are adaptable for use on, or to be driven by a punch press which produces the forces required for consolidating. More particularly, this invention concerns a punch assembly wherein a pair of free floating punches are contacted by a swivelable body so mounted in a housing that a load produced by a punch press is distributed *equally* on the punches. By this means, delay and fuse assemblies having powdered combustible material loosely contained within them, which is to be ignited, can be prepared.

Such delay and fuse assemblies are very desirable in devices such as aerial flares, bombs and similar objects which depend upon a predictable time delay before a main explosive or illuminating charge is to be initiated. For example, certain illuminating flares, particularly those adapted to be launched by artillery field pieces such as the 155 millimeter howitzer, are dimensionally and ballistically matched with the regular 155 mm. explosive round, i.e., the flare or illuminating round can be fired from the artillery piece without changing the propelling charge and with little or no change in gun position and setting in the field.

In the usual instance, flares of the above type have a forward "nose" portion which contains a mechanical timer, or time fuse adapted to ignite an initial, or primary expelling charge. This ignited charge creates pressure gas which causes the release of a first, or drogue type of parachute and simultaneously ignites a combustible delay assembly, which if properly compacted, or consolidated in manufacture, will burn for an accurately predictable time period. At the end of the delay burning time, a secondary expelling charge is ignited which creates pressurizing gas to release the main flare body containing combustible illuminant, and ignites said illuminant. The main flare body usually contains a cannister and is attached to a main parachute which permits a slow descent to illuminate a preselected target area.

It is, however, quite obvious that ignition of the flare should desirably not occur, that is, should be delayed, until the flare is in a position over a preselected site, or target area to be illuminated. In practice it has been found that a delay or fuse assembly comprising a pair of parallel columns, or delay trains of carefully compacted, or consolidated combustible material, disposed within preferably a metal body provides proper time delay, in flight, between the primary expelling charge and the secondary expelling charge to achieve the illuminating objectives

above described. It should also be here noted that while either one of the two delay columns or trains will accomplish the desired result, it is usual and prudent, to provide a second, identical delay to increase reliability.

In practice delay trains with which the invention herein is concerned are prepared by first loading in the columns a "gasless" ignition composition followed by one or more increments (in the above 155 mm. example, three increments are used) of manganese delay powder, capped by a single increment of black powder. The gasless ignition composition usually consists of a formulation of powdered zirconium, ferric oxide and diatomaceous earth and serves as the ignition link between the primary expelling charge and the manganese delay train. It is selected for ease of ignition and to have a burning temperature of sufficient high order to insure ignition of the manganese composition. The manganese delay composition is formulated to burn at a controlled rate to provide proper delay between primary and secondary expelling charge ignition. When the burning surface of last manganese increment in the delay train reaches the black powder, it ignites the black powder which fires with sufficient force to ignite the secondary expelling charge (also black powder).

As noted above, the present invention is concerned with a device and method for compacting or consolidating the increments in the delay train in the delay assembly. In prior art methods for accomplishing this objective each train in each column has heretofore been compacted individually and in sequence, often resulting in gross variations in burning rate of the thereby compacted delay train. Attempts have also been made to consolidate both columns simultaneously, but results were largely unsatisfactory due to *unequal* distribution of the consolidating loads applied. This occurs because, in practice, each increment in each column of the assembly is first volumetrically dispensed therein using suitable scoops, or measuring cups to pour into the columns, uncompacted material having the loose form of powder or the like, after which the assembly is positioned on a punch press and a consolidating load impressed. Thus, it can be seen that prior to consolidating, the loose material will often be at different levels and of varying densities, hence attempts to consolidate both columns simultaneously, usually results in unequal force distribution.

It is therefore an object of this invention to provide a dual force transmitting punch assembly wherein a pair of delay trains in a delay assembly of a fused projectile and the like are subjected to equal consolidating loads simultaneously.

It is an additional object of this invention to provide a device of the character referred to wherein free floating punches are employed to consolidate loose material in a pair of columns in a delay or fuse assembly under equal forces, simultaneously, from a single force producing instrument.

A further object of this invention is to provide a device of the character described which is of simple construction, self-compensating with respect to both wear and alignment and capable of transmitting equal forces through each of two punches regardless of the relative level of the punches.

Other objects and advantages of the present invention will become apparent to skilled artisans from a consideration of the following description of a preferred and one additional embodiment thereof, especially when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a pictorial, exploded view of a preferred embodiment of the invention;

FIGURE 2 is a front elevation of an additional embodiment of the invention, partly in section;

FIGURE 3 is a side elevation, partially sectioned of the invention of FIGURE 2;

FIGURE 4 is a side elevation, partially in section, showing the invention in a punch press prior to consolidating the delay composition in a delay assembly; and

FIGURE 5 is a sectional view of the front portion of a typical flare projectile showing the relative position of a delay assembly therein after being consolidated by the invention.

Referring now to the drawings, and in particular to FIGURE 1, there is illustrated a preferred embodiment of the invention comprising a punch assembly **10**, which includes a hollow housing **11**. Housing **11** has a threaded upper portion **12** which is provided for attachment thereof to a vertical punch press **13** (FIGURE 4). A pivot pin **14** extends in swivelling relationship therewith through a pair of opposite walls **15** in housing **11** in openings **16** (one only shown in FIGURE 1) therein. Pivot pin **14** also extends through a hole **17** in a pivot, or toggle bar **18** being in press fitted, or non-slipping engagement therewith. Bar **18** is thereby swivelably, or rotatably supported by pin **14** in housing walls **15**, being dimensioned to freely rotate, or swivel about the long axis thereof within housing **11**. Pivot bar **18** is symmetrically formed with a pair of lobes **19**. Lobes **19** have rounded, hardened surfaces, the center of which are on the transverse (left to right in FIGURE 1) center line of hole **17**, extremities of which are equidistant from the center thereof. Pin **14** can alternatively be fixedly attached in walls **15** and bar **18** swivelled thereon in housing **11**.

Housing **11** is closed at its bottom surfaces by a bushing plate **20** fastened thereat by a plurality of bolts (one shown in FIGURE 1), and has a pair of through holes **21** into which is press fitted a pair of bushings **22**, which are provided to support a pair of free floating punches **23** therein, and are located equidistantly from the lateral axis (front to rear in FIGURE 1). The term "free floating" as used herein refers to the fact that punches **23** contact bushings **22** so as to be freely movable vertically therewithin. Bushings **22** are therefore made of hard, smooth surfaced material such as steel or other suitably hard substance available. Thus, punches **23** are fitted in bushing **22** under relatively close tolerances circumferentially, but easily movable vertically therein, thereby avoiding unwanted misalignment problems in use as will become apparent. Punches **23** are further formed with heads **24**, which have their top surfaces, in operation, contacting the lower, hardened surfaces of lobes **19** of bar **18**.

FIGURES 2 and 3 illustrate another embodiment of the invention wherein a modified pivot or toggle bar **18***a* is shown. Modified bar **18***a* is, however, swivelably, or rotatably mounted in housing **11** in the same way as the previously described embodiment, on pivot pin **14**. In this embodiment, modified toggle bar **18***a* has bifurcated ends **25** and is provided with a pair of transverse holes into which a pair of clevis or dowel pins **26** are fixedly inserted. Pins **26** are positioned in the body of bifurcated bar **18***a* adjacent each side of pin **14** and are diametrically sized to have their lower, circumferential portions extend into bifurcations **25**, and their centers positioned on the transverse center line of pin **14**. Punches **23** extend into the space between bifurcated ends **25** and contact the exposed, circumferential portions of pins **26**, as best seen in FIGURE 3.

FIGURE 4 illustrates the punch assembly **10** of the invention attached to punch press **13** in a position at the beginning of a compacting or consolidating stroke. Also shown in FIGURE 4 is a delay or fuse assembly **27** held in a jig or fixture **28** on the work table **29** of press **13**. Delay assembly **27** is positioned on table **29** in inverted position to facilitate filling columns **30** therein to form a delay train **31** (see also FIGURE 5) with combustible material which is to be consolidated. Delay assembly **27** shown also in FIGURE 2 in dotted outline with punches **23** inserted in columns **30** for alignment therewith; jig, or fixture **28** being omitted for clarity. A flash shield **43** surrounds assembly **10** in FIGURE 4 for protection of the punch press operator while using the invention who, as indicated in this figure, works and observes from the left.

FIGURE 5 illustrates the position of delay assembly **27** in the forward end of a flare projectile **32**. As shown, delay assembly **27** comprises a body **33** with delay train **31** in columns **30** fully compacted and comprising a black powder capping **34**, three increments of manganese delay composition **35** and a single increment of a gasless powder composition **36**. Forward of delay assembly **27** is a primary expelling charge **37** composed of a fast burning composition which abuts body **33**. A mechanical timing fuse **38** forwardly abuts charge **37** in the nose of projectile **32**.

Delay assembly **27** is threadedly engaged in the forward end of an inner housing **39** of projectile **32** and surrounds a secondary expelling charge **40** composed of black powder which abuts the aft end of assembly **27**. Charge **40** may be encased in a silk bag or other cover (not shown) in practice, which is penetrable by the igniting force of black powder increment **34** of delay **27**.

Housing **39** is slidably positioned in projectile **32** and encloses a casing **41** containing the illuminating charge or candle **42** of flare **32**, which abuts the aft end of expelling charge **40**.

In operation of the invention a delay assembly **27** is positioned on table **29** of press **13** in inverted position, i.e., with the aft end, as seen in FIGURE 5, upward. Assembly **27** is held in position in jig **28** between an alignment bar **43** and a hold-down bar **44** thereby insuring that punches **23** are in vertical alignment with columns **30** in delay assembly **27**. Alignment bar **43** includes a pair of vertical press fitting pins (not shown) which extend therefrom into the now inverted forward openings of columns **30** to control the depth of the forward face of the gasless ignition powder **36**. As indicated hereinabove the material making up delay trains **31** are volumetrically dispensed into train holes or columns **30** by means of any suitable funnel, scoop or dispensing ladle (not shown). Following addition of gasless ignition powder **36** a first increment of manganese delay composition **35** is dispensed into columns **30** and a consolidation load on the order of 1,000 lbs. is impressed on the surface of composition **35** in each column **30** by press **13** through assembly **10**.

As indicated elsewhere herein, the invention's unique advantages and usefulness lies primarily in the accomplishment thereby of *simultaneously* consolidating the material contained in both columns **30**. As stated, the material is volumetrically dispensed, or loaded therein and may, prior to consolidation be at different levels. With the invention herein the consolidation force supplied by press **13** is transmitted to the surfaces of the material in columns **30** in *equal portions* since free floating punches **23** will seek their own levels and will come to rest with their lower ends on the surface of material to be compacted. As force is applied, toggle bar **18** (or **18***a*) will swivel or rotate about pin **14** and the force produced by press **13** will be divided thereby—half being transmitted to each punch **23**.

Similarly as each manganese increment **35** is placed or poured into columns **30**, consolidation is effected in the same manner. The final black powder increment, or capping **34** is also compacted in the same way, after first trimming, or cutting back the excess manganese increment **35** to the desired length.

It has been shown through actual test that improper consolidation of the combustible material in a delay or fuse assembly is at the base of most problems in the art of artillery delivery of flares and other such projectiles over preselected targets. The primary defect in prior attempts to load delay assemblies has been their failure to meet a desired, or required burning time, which is usually attributed to improper consolidation either because of poor alignment or improper distribution of compacting loads. Another defect resulting from improper consolidation is failure of the delay train to sustain ignition, i.e.,

failure of gasless ignition powder **36** to maintain burning until its burning surfaces reaches black powder capping **34**. Thus, the consolidating step herein described and the novel means for accomplishing it is the single most important part of projectiles of the general type wherein a predetermined delay between events in a sequence is required. Such a device is exemplified in FIGURE 5 wherein the head end of projectile **32** is illustrated.

Projectile **32** is designed to be fired from a 155 mm. howitzer, on a trajectory which places it over a target area at a prespecified altitude, after which a fully opened parachute descent of an illuminating flare is effected. In actual firing conditions mechanical timing fuse **38** is set for the desired fuse actuation time. Projectile **32** upon leaving the barrel of the howitzer is undergoing rotation, therefore the timer of fuse **38** is initiated in response to rotation. Upon fuse actuation at the end of a predetermined time, primary expelling charge **37** fires, driving housing **39**, together with delay assembly **27** and cannister **41** and its contents **42** afterwardly out of the body of projectile **32**. This explosion ejects a drogue parachute (not shown) from the aft end of projectile **32** which provides initial deceleration of housing **39** and its contents. At the same time, delay trains **31** in columns **30** of delay assembly **27** are ignited. Delay trains **31** which have been consolidated by use of punch assembly **10**, the invention described and claimed herein, burn for a period of approximately 7.5 seconds, during which time ejected cannister **41**, candle **42**, housing **39** and assembly **27** are being decelerated by the drogue parachute, above mentioned. Also during this time it is usual to provide some means such as extendible braking fins or the like (also not shown) to halt rotation of the spinning, now-ejected, components.

At the end of the delay period, the burning surface of final increment **35** reaches and ignites black powder capping **34**, which, in turn, ignites secondary expelling charge **40**. Firing of expelling charge **40** causes ejection of cannister **41** from housing **39** and also ejects a main flare parachute (not shown) usually packed in the aft end of projectile **32** and attached to cannister **41**. Simultaneously illuminant, or flare candle **42** is ignited and provides illumination during descent thereof by the main parachute over the traget area.

As is apparent from the foregoing, delay assembly **27** performs a very important function in projectiles of the type above generally referred to. Therefore, burning delay train **31** must be reliable, and since two such trains are most frequently used to increase reliability, they must have as many of the same characteristics as possible.

By use of the invention hereinabove described and claimed below, this has now become realizable to an unprecedented degree, since the recognized main source of difficulty, improper consolidation of the combustible material, has been practically eliminated.

What is claimed is:

1. A punch assembly adaptable for use in a punch press to consolidate combustible solid materials in powder train delay and fuse devices and the like comprising:

a housing having walls defining a chamber, a bushing plate having a pair of holes extending therethrough, said plate removably attached to said housing and forming a bottom for said chamber;

a hollow bushing in each of said holes, said bushings being press fit therein;

a swivelable pivot bar in said housing;

pivot means in said chamber terminating in opposite walls of said housing for supporting said pivot bar; and

a pair of elongated punches contacting said pivot bar in said housing and extendable through said bushings in said holes for consolidating said combustible material in said delay and fuse devices under a preselected load produced by said punch press.

2. The punch assembly of claim **1** wherein said pivot means is a cylindrical pin passing through said pivot bar in press fitted engagement therewith having its ends extending into said chamber opposite walls in a slip fit for swivelling said pivot bar.

3. The punch assembly of claim **1** wherein said pivot bar includes a pair of press fitted dowel pins, the outer periphery of which contact said punches in force transmitting engagement therewith in said housing.

4. The punch assembly of claim **1** wherein said pivot bar comprises a body having a pair of downwardly extending, rounded surfaces, each of said surfaces contacting one of said punches in force transmitting engagement therewith in said housing.

References Cited

UNITED STATES PATENTS

2,395,494 2/1946 Mosher ---------- 86—30

BENJAMIN A. BORCHELT, Primary Examiner

STEPHEN C. BENTLEY, Assistant Examiner

U.S. Cl. X.R.

86—30