A device for determining projectile velocity at a gun barrel muzzle, the device including at least two sensors spaced some distance apart be integrated on or directly in the gun barrel. During the passage of the projectile, the sensors undergo expansion due to the gas pressure at the base of the projectile and the pressure of the rotating band of the projectile on the inside of the gun barrel. This expansion is converted to an electric signal, which, if necessary, is amplified and then supplied to a signal processing device connected on the output side of the sensors. High-temperature-resistant quartz sensors in the form of longitudinal measuring pins are preferably used as the sensors, which are installed either in a carrier ring or around the gun barrel or directly in the gun barrel.
Fig. 3
DEVICE FOR DETERMINING PROJECTILE VELOCITY, ESPECIALLY AT THE MUZZLE OF A GUN BARREL

BACKGROUND OF THE INVENTION

[0001] CH 691 143 A5 describes a device for measuring projectile velocity at the muzzle of the barrel of a gun with a high rate of fire. It comprises two sensors, which are arranged some distance apart on a support tube, and respond to changes in magnetic flux and are connected with analysis electronics. Each sensor has a pair of coils that consists of two coils and a closed magnetic circuit.

[0002] DE 697 09 291 T2 (EP 0 840 087 B1) discloses means for controlling the initial velocity of a projectile. A sensor device is provided that can measure a parameter related to the muzzle velocity. This is accomplished with the use of sensors, which are installed at least in or on the gun barrel and can detect a higher pressure in the gun barrel that develops due to the heating of the propellant gases in the gun barrel. Strain gages are proposed as sensors, which are fitted in such a way that they have contact with the gun barrel. This is intended to allow easy measurement of the expansions of the gun barrel. The motion and thus the velocity of the projectile are determined from the difference in time between the recording of the passage of the projectile by the two individual sensors.

SUMMARY OF THE INVENTION

[0003] Building on this principle, the objective of the invention is to specify another device for determining the velocity of a projectile.

[0004] This objective is achieved by a device comprising of a signal analysis unit, an amplifier stage, and at least two sensors or pairs of sensors which are integrated on and/or in the gun barrel. The sensors are operative to measure parameters related to velocity of the projectile in the gun-barrel and to transmit the parameters from an output side of the sensors to the signal analysis unit via the amplifier stage. The sensors are integrated in a recess or passage of a carrier ring mounted on the gun barrel or are integrated directly in recesses of the gun barrel.

[0005] The invention is based on the idea of integrating at least two spaced sensors or pairs of sensors on or directly in the gun barrel. During the passage of the projectile, the sensors undergo expansion due to the gas pressure at the base of the projectile and the pressure of the rotating band of the projectile. This expansion is converted to an electric signal, which, if necessary, is amplified and then supplied to a signal processing device connected on the output side. The sensors are preferably quartz sensors in the form of longitudinal measuring pins, which are mounted either in a carrier ring on or around the gun barrel or directly in the gun barrel. Quartz sensors have the advantage that they are able to convert even the smallest pressure changes to signals, and so are very robustly constructed, and can be precisely fitted, i.e., integrated in tight contact with the gun barrel without slipping. This means that mechanical loads of the gun barrel have no effect on the result of the indirect pressure measurement. Furthermore, the sensors are not directly exposed to the gas pressure and are integrated in a solid structure in addition to their own housing.

[0006] The integration of the sensors on or in the gun barrel makes it possible to measure the muzzle velocity of full-caliber and subcaliber ammunition without any interference with the measurement, for example, by the sabots.

[0007] Another possibility consists in direct incorporation in the muzzle brake itself. This provides a simple installation site, especially when it has slots instead of bores.

[0008] Other features and advantages of the present invention will become apparent from the following description of the invention which refers to the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 shows a schematic representation of an arrangement of sensors on the gun barrel; FIG. 2 shows a schematic representation of the arrangement of the sensors directly in the gun barrel; and FIG. 3 shows a cross-sectional view of the incorporation of a sensor in the gun barrel.

DETAILED DESCRIPTION OF THE INVENTION

[0012] FIG. 1 is a schematic representation of a gun barrel 1, which in this case has at least two sensors 2, 3 on its circumference. The sensors are preferably integrated in a carrier ring 4, 5, which has a recess 4.1, 5.1, in this case a bore, for holding the given sensor 2, 3. The recesses 4.1, 5.1 can be formed either radially or tangentially—or in the case of pairs of sensors, radially and tangentially—with respect to the axis of the barrel. The carrier rings 4, 5 are preferably mounted in the muzzle region 6 at a well-defined distance from each other and from the muzzle. A signal processing or signal analysis unit 8 is connected to the output side of an amplifier stage 7, which is electrically connected with the sensors 2, 3. The amplifier stage 7 can be dispensed with if the signal amplitudes of the sensors 2, 3 can be regarded as sufficiently large for further processing.

[0013] The sensors 2, 3 are designed in such a way that they are seated with a precise fit in the bores 4.1, 5.1 and are in mechanical contact with the gun barrel 1 via the carrier ring 4, 5. The carrier rings 4, 5 are preferably shrunk fit onto the gun barrel 1. To this end, the outside diameter of the barrel can be turned at the places 9, 10 provided, at which each cylindrical carrier ring 4, 5 is shrunk fit onto these cylindrical places 9, 10. The entire inside surface of the carrier rings 4, 5 is thus in contact with the outside surface of the gun barrel 1.

[0014] In FIG. 2, the sensors 12, 13 are directly integrated in the gun barrel 1. To this end, recesses 14, 15 are preferably in the form of bores, are made in the gun barrel 1. The recesses 14, 15 can be formed either radially or tangentially—or in the case of pairs of sensors, radially and tangentially—with respect to the axis of the barrel. In this regard, the sensors 12, 13 are preferably inserted in the recesses 14, 15 from the outside.

[0015] There is another possible variant, but it is not illustrated in the drawings. In this variant, the gun barrel has at least two bulges spaced some distance apart, under or in which the sensors are located. These ridges are formed at the time the barrel is produced and are integral parts of the gun barrel, so that the recesses are formed radially or tangentially in the ridges.
Another possibility, which is shown in FIG. 3, consists in nearly completely utilizing the diameter of the inside wall 1.1 of the barrel; in this case, the sensors 12, 13 may not be larger than this inside wall 1.1 and may not extend into the gun barrel 1. The sensors 12, 13 are protected by a thin remaining portion 14 of the inside wall, so that they are not directly exposed to the gas pressure.

As is shown in FIG. 1, a signal analysis unit 8 is connected to the output side of the sensors 12, 13, at least via an amplifier stage 7. Here too, the analysis is performed by well-known means, depending on the type and utilization of the measurement. For example, the motion and thus the velocity of a projectile (not shown) are determined from the difference in time between the recording of the passage of the projectile by the two individual sensors.

So-called high-temperature quartz longitudinal measuring pins with positive or negative charge output may be used as sensors 2, 3, 12, 13. These are capable of measuring expansions in solid structures. The expansion of the structure (gun barrel 1 with carrier ring 4, 5 or gun barrel alone) occurs as follows: The gas pressure generated by the combusted propellant charge powder (not shown) at the base of the projectile (also not shown) and the pressure of the rotating band of the projectile on the inside of the gun barrel expands the gun barrel 1 during the passage of the projectile. This expansion is transmitted to the housing of the longitudinal measuring pin 2, 3, 12, 13. The quartz in the housing detects the expansion and produces a charge. The resulting signal is transmitted to the signal analysis unit 8 via the amplifier stage 7.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

What is claimed is:

1. A device for determining projectile velocity at a muzzle of a gun barrel, comprising:
   - a signal analysis unit;
   - an amplifier stage; and
   - at least two sensors or pairs of sensors, which are integrated on and/or in the gun barrel and are operative to measure parameters related to velocity of a projectile and transmit the parameters from an output side to the signal analysis unit via the amplifier stage for analysis, the sensors being integrated in a recess or passage of a carrier ring mounted on the gun barrel or being integrated directly in recesses of the gun barrel.

2. The device in accordance with claim 1, wherein the sensors are high-temperature-resistant longitudinal measuring pins.

3. The device in accordance with claim 1, wherein the gun barrel has an outside diameter turned in order to hold the carrier rings in suitable places so that the carrier rings can be shrunk fit in these places.

4. The device in accordance with claim 1, wherein the recesses or passages are bores.

5. The device in accordance with claim 2, wherein the sensors are quartz measuring pins.

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