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(54) **ADJUSTABLE TUNING DEVICE**

(71) Applicant: **Aaron Hipp**, Orient, OH (US)

(72) Inventor: **Aaron Hipp**, Orient, OH (US)

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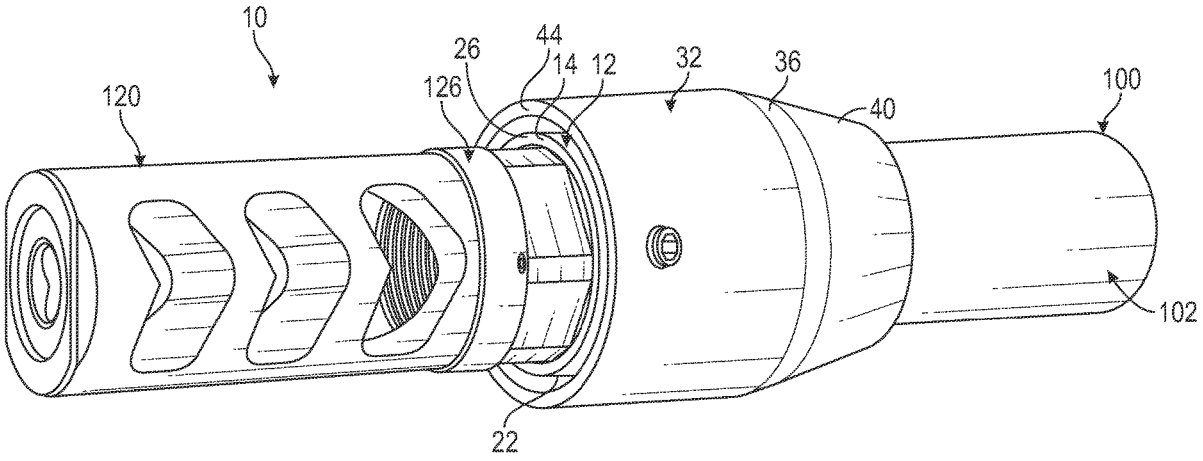
CPC ***F41A 21/30*** (2013.01)

(57) **ABSTRACT**

An adjustable tuning device has a cup having a base defining an aperture configured to closely receive a limited rear portion of the muzzle portion such that a forward portion of the muzzle portion extends forward of the base, the cup having a rear surface configured to abut the forward-facing shoulder of a barrel, the cup being externally threaded, and a weight having internal threads configured to mate with the externally threaded cup and operable to move in a range of axial positions with respect to the cup. The cup may have a skirt extending rearwardly of the base. The weight may taper to a reduced diameter at a rear end. The cup may have an external diameter at an externally threaded portion, and the weight may have a rear portion having an internal diameter less than the external diameter of the cup.



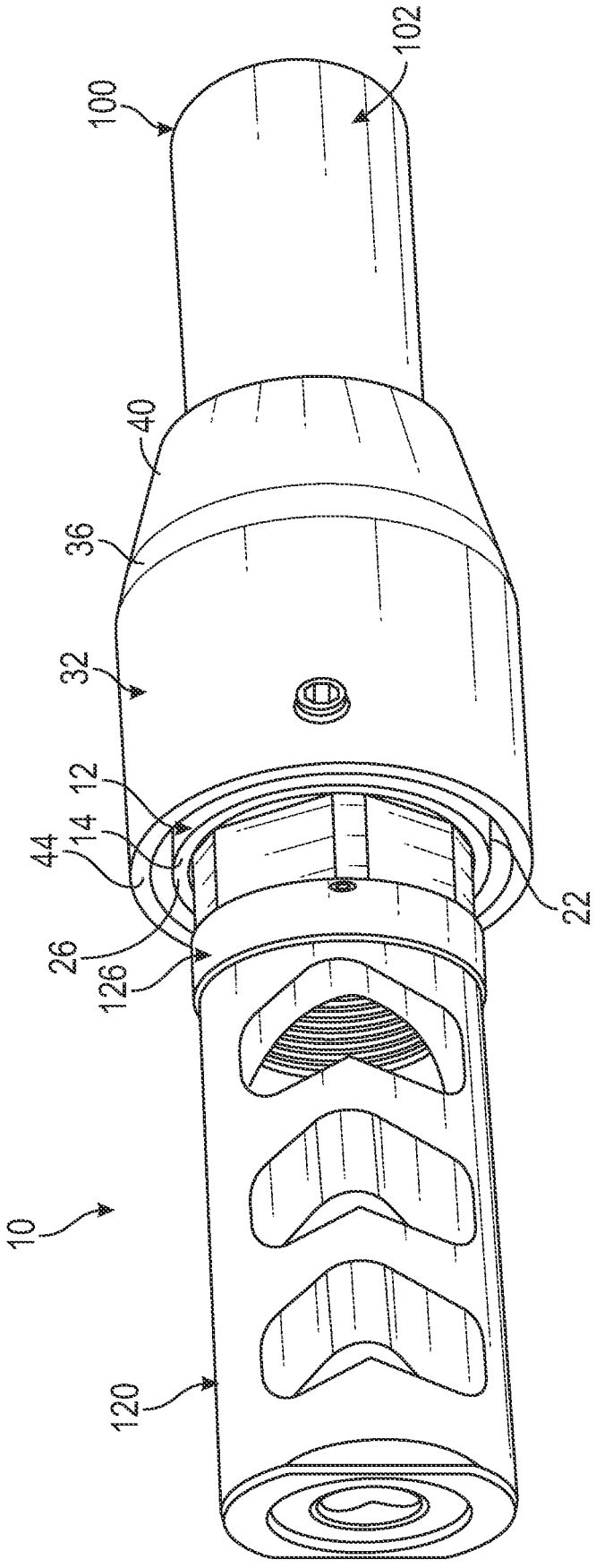


FIG. 1

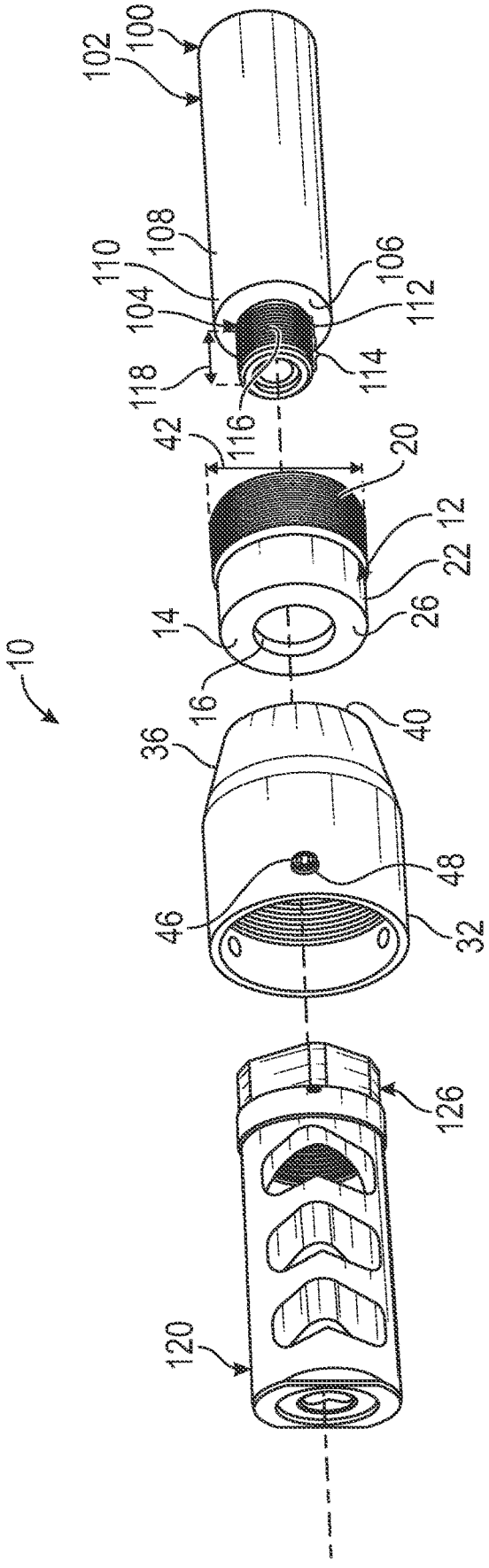

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FIG. 2

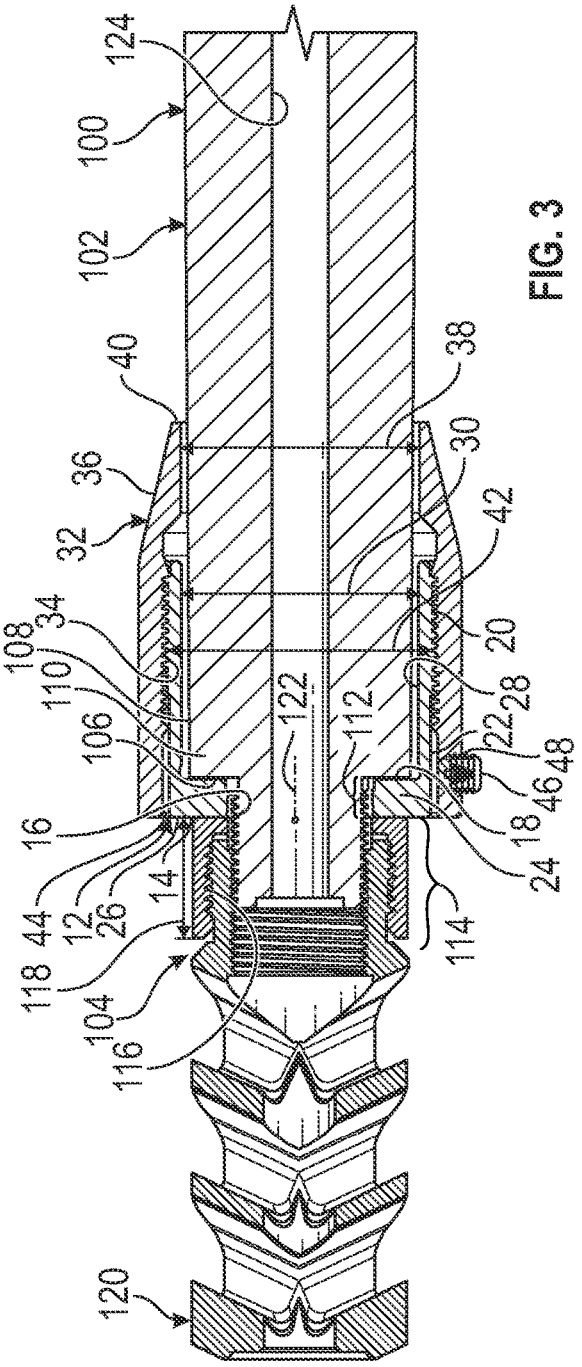
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FIG. 3

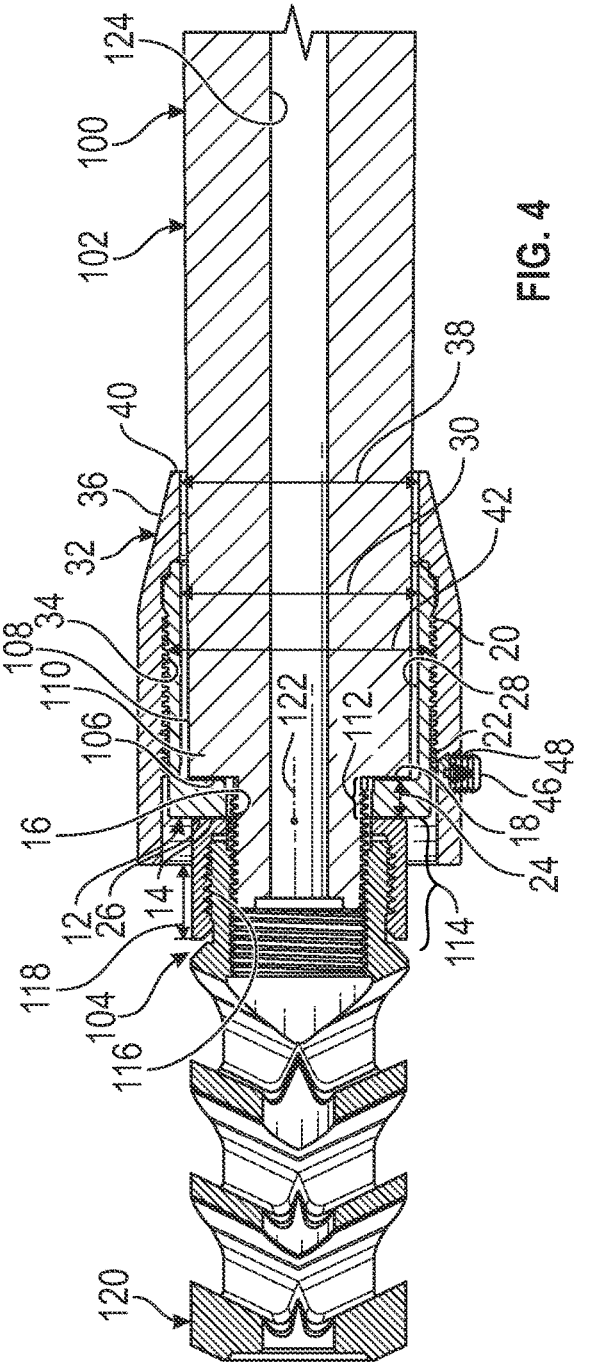
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FIG. 4

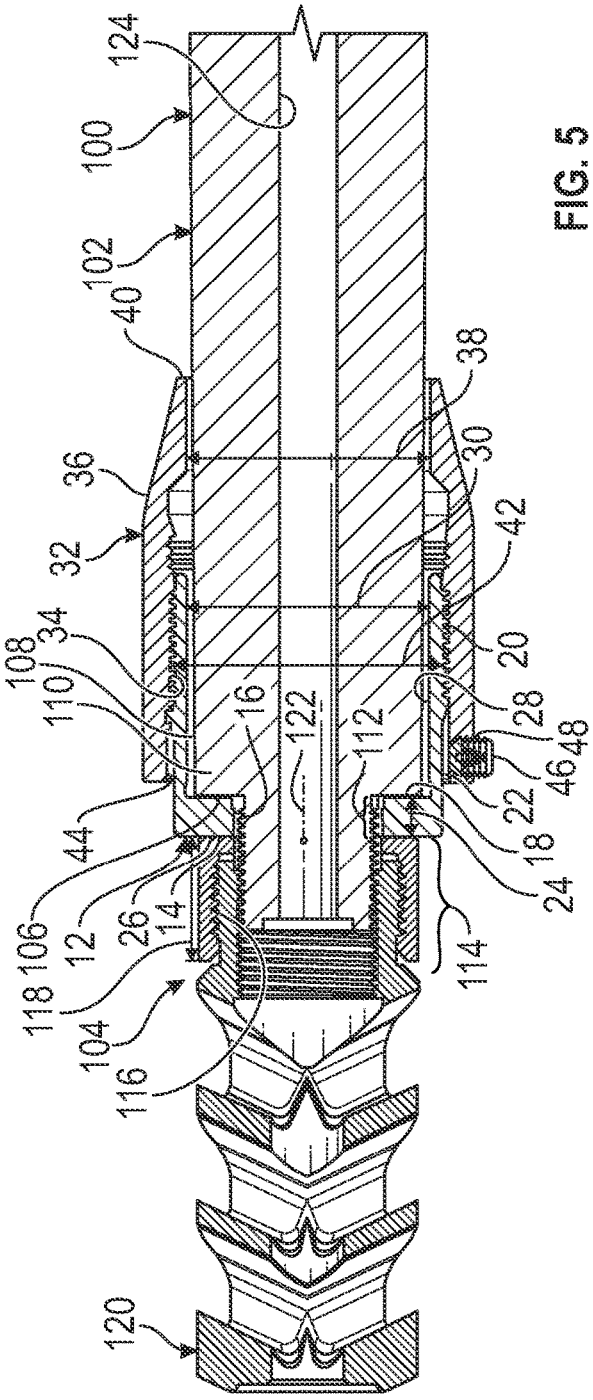
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FIG. 5

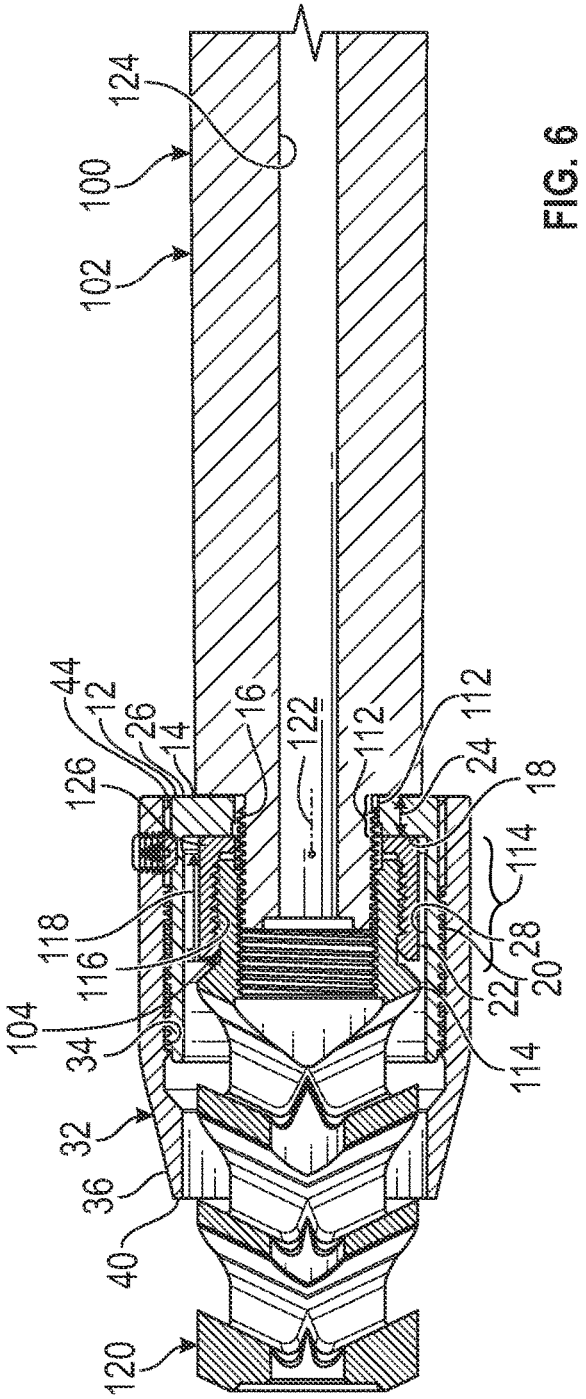
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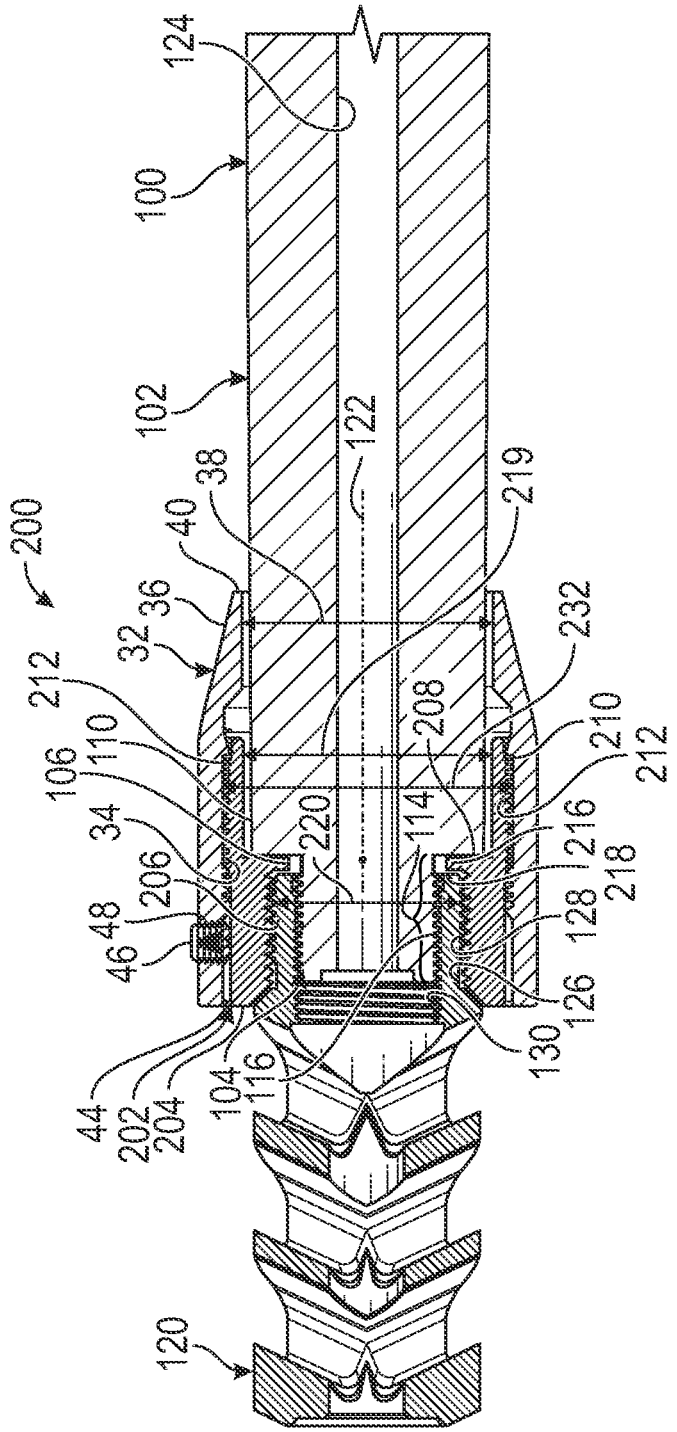
FIG. 6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116
120

FIG. 7

ADJUSTABLE TUNING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/033,337 filed on Jun. 2, 2020, entitled "Adaptive Tuning System (ATS)," which is hereby incorporated by reference in its entirety for all that is taught and disclosed therein.

FIELD OF THE INVENTION

[0002] The present invention relates to firearms, and more particularly to an adjustable tuning device that enables the use of a user-selected muzzle device in combination with the adjustable tuning device. It should be appreciated that the present invention can be used with air rifles and other "projectile launching devices," and that "firearm" is used in the description and claims broadly to indicate any such devices, and is not limited to the narrow regulatory or technical definition of firearms. A "projectile launching device" can be any device utilizing a force to accelerate an object into the environment, which is subsequently allowed to move solely under the influence of gravity and air resistance.

BACKGROUND AND SUMMARY OF THE INVENTION

[0003] Barrel tuners enable a user to improve the accuracy of a host firearm by adding an adjustable weight to the muzzle of the barrel to manage barrel vibration during firearm discharge. The barrel tuner can be adjusted to not only compensate for the unique characteristics of the host firearm, but also to compensate for variables associated with the ammunition, propellants, fire control, and barrels used to ensure consistent performance.

[0004] Although many prior art barrel tuners exist, they have several disadvantages. First, many require a gunsmith to modify the host firearm's barrel by adding contouring and/or additional threads behind the existing muzzle threads to accommodate the barrel tuner. Second, many combine a proprietary muzzle brake combined with the barrel tuner and do not allow the user to use a user-selected muzzle device such as a muzzle brake, suppressor, or thread protector with the barrel tuner. Third, even those prior art barrel tuners that use only the existing muzzle threads do not support the use of a user-selectable muzzle device that shares the existing muzzle threads.

[0005] Therefore, a need exists for a new and improved adjustable tuning device that enables the use of a user-selected muzzle device in combination with the adjustable tuning device. In this regard, the various embodiments of the present invention substantially fulfill at least some or all of these needs. In this respect, the adjustable tuning device according to the present invention substantially departs from the conventional concepts and designs of the prior art, and in doing so provides an apparatus primarily developed for the purpose of enabling the use of a user-selected muzzle device in combination with the adjustable tuning device.

[0006] The present invention provides an improved adjustable tuning device, and overcomes the above-mentioned disadvantages and drawbacks of the prior art. As such, the general purpose of the present invention, which will be described subsequently in greater detail, is to provide an improved adjustable tuning device that has all the advantages of the prior art mentioned above.

[0007] To attain this, the preferred embodiment of the present invention essentially comprises a cup having a base defining an aperture configured to closely receive a limited rear portion of the muzzle portion such that a forward portion of the muzzle portion extends forward of the base, the cup having a rear surface configured to abut the forward-facing shoulder of a barrel, the cup being externally threaded, and a weight having internal threads configured to mate with the externally threaded cup and operable to move in a range of axial positions with respect to the cup. The cup may have a skirt extending rearwardly of the base. The weight may taper to a reduced diameter at a rear end. The cup may have an external diameter at an externally threaded portion, and the weight may have a rear portion having an internal diameter less than the external diameter of the cup. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject matter of the claims attached.

[0008] There has thus been outlined, rather broadly, the more important features of the invention in order that the detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is an isometric view of the current embodiment of an adjustable tuning device constructed in accordance with the principles of the present invention in use with a muzzle brake attached to a barrel in the forward condition.

[0010] FIG. **2** is an exploded view of the adjustable tuning device of FIG. **1** detached from the barrel.

[0011] FIG. **3** is a side sectional view of the adjustable tuning device of FIG. **1** attached to a barrel in the forward condition with the weight in the centered position.

[0012] FIG. **4** is a side sectional view of the adjustable tuning device of FIG. **1** attached to a barrel in the forward condition with the weight in the forward position.

[0013] FIG. **5** is a side sectional view of the adjustable tuning device of FIG. **1** attached to a barrel in the forward condition with the weight in the rearward position.

[0014] FIG. **6** is a side sectional view of the adjustable tuning device of FIG. **1** attached to a barrel in the reversed condition to accommodate a shorter barrel with the weight in the centered position.

[0015] FIG. **7** is a side sectional view of an alternative embodiment of the adjustable tuning device where the cup serves as the locking/jam nut for a self-timing muzzle brake.

[0016] The same reference numerals refer to the same parts throughout the various figures.

DESCRIPTION OF THE CURRENT EMBODIMENT

[0017] An embodiment of the adjustable tuning device of the present invention is shown and generally designated by the reference numeral **10**.

[0018] FIGS. **1-6** illustrate the improved adjustable tuning device **10** of the present invention. More particularly, FIGS. **1** and **3-6** shows the adjustable tuning device in use attached to the muzzle portion **104** of the barrel **102** of a firearm **100**, which is a rifle in the current embodiment. FIGS. **1** and **3-5** show the adjustable tuning device in the forward condition

used with longer barrels. FIG. **6** shows the adjustable tuning device in the reversed condition used with shorter barrels. The barrel includes a forward-facing shoulder **106** rearward of the muzzle portion and a forward barrel portion **108** rearward of the forward-facing shoulder having an exterior profile **110**.

[0019] The adjustable tuning device **10** has a cup **12** having a base **14** defining a threaded aperture **16**. The threaded aperture is configured to closely receive a limited rear portion **112** of the muzzle portion **104** such that a forward portion **114** of the muzzle portion extends forward of the base. The cup has a rear surface **18** configured to abut the forward-facing shoulder **106** of the barrel **102**. The cup is externally threaded with external threads **20** and has a skirt **22** extending rearwardly of the base. The skirt defines an internal space **28** with a diameter **30** greater than the exterior profile **110** of the barrel, and is externally threaded with the external threads **20**. However, when the adjustable tuning device acts as a replacement nut on self-timing muzzle brakes, attached to or as the endcap on an airgun barrel shroud, the diameter **30** may not need to be greater than the barrel or shroud diameter. Depending on the characteristics of the host firearm, the cup may abut a barrel shroud or shroud endcap instead of the barrel shoulder, particularly in the case where the host firearm is an airgun.

[0020] The muzzle portion **104** of the barrel **102** is threaded with muzzle threads **116**, and the threaded aperture **16** of the cup **12** mates with the muzzle portion. The base **14** of the cup has a limited thickness **24** less than half a length **118** of the muzzle portion such that a major portion (the forward portion **114** of the muzzle portion) is exposed to receive and connect to a user-selected muzzle device **120**. In the current embodiment, the muzzle device is a muzzle brake, which is a separate muzzle device configured for attachment to the forward portion of the muzzle portion while the cup is attached to the limited rear portion **112** of the muzzle portion. The base of the cup is compressively captured between the muzzle device and the forward-facing shoulder **106** of the barrel or barrel shroud. The base of the cup has a forward-facing surface **26** configured to be abutted by the muzzle device connected to the forward portion of the muzzle portion. In the current embodiment, the limited thickness of the base of the cup is less than ¼ inch and less than the diameter of the threaded aperture.

[0021] A weight **32** has internal threads **34** configured to mate with the external threads **20** on the skirt **22** of the cup **12**. The weight is operable to move in a range of axial positions with respect to the cup along barrel axis **122** defined by the barrel bore **124** of the barrel **102**. In the current embodiment, the weight has a rear tapered portion **36** that tapers to a reduced internal diameter **38** at a rear end **40**. The reduced internal diameter accommodates barrels having an exterior profile **110** with a diameter of up to 1.08 inch approximately 2 inch behind the muzzle forward facing shoulder **106**. The taper helps maintain a closer fit to the barrel exterior profile to avoid catching the weight on barricades or external objects. However, it should be appreciated that the weight does not typically contact the barrel exterior profile. The cup has an external diameter **42** at the external threads **20**, and the reduced internal diameter of the weight at the rear tapered portion is less than the external diameter of the cup in the current embodiment. The weight has an open front end **44** configured to enable attachment of the muzzle device **120** forward of the base **14** of the cup to the muzzle threads **116** on the muzzle portion **104** of the barrel. In alternative embodiments, a smaller, non-tapered version of the weight can be used for hunting rifles, and a larger version of the weight can be used for larger barrel profiles and airgun shrouds.

[0022] FIGS. **3-5** illustrate the improved adjustable tuning device **10** of the present invention. More particularly, FIG. **3** shows the weight **32** in the centered position with respect to the cup **12**. FIG. **4** shows the weight in the forward position with respect to the cup with a portion of the muzzle device **120** received by the open front end **44** of the weight, but not contacted by the weight. FIG. **5** shows the weight in the rearward position with respect to the cup. Changes in weight position are accomplished by loosening a set screw **46** received in a threaded aperture **48** in the weight, rotating the weight about the external threads **20** of the skirt **22** to the desired position, and tightening the set screw against the skirt to prevent undesirable movement of the weight in response to vibrations or recoil and impact forces. Different positions of the weight change the characteristics of the barrel when the firearm **100** is discharged, and a selected weight position will improve the accuracy of the firearm by the mass of the weight tuning the harmonic vibrations of the barrel.

[0023] FIG. **6** illustrates the improved adjustable tuning device **10** of the present invention. More particularly, the adjustable tuning device is shown in the reversed condition with the weight **32** in the centered position. In the reversed condition, the selected muzzle device **120** is received by the rear tapered portion **36** of the weight, but is not contacted by the weight. The open front end **44** of the weight receives the exterior profile **110** of the barrel **102**, but does not contact the barrel exterior profile. The reversed condition is used with shorter barrels where moving the weight to the rearward position would be obstructed by the rifle stock or chassis (not shown), or with pistols or other firearm designs that do not allow for the weight to extend rearward of the muzzle portion **104**.

[0024] It should be appreciated that the adjustable tuning device **10** is intended to be used with a selected muzzle device **120** to secure the cup **12** against the forward-facing shoulder **106** of the barrel **102**. The muzzle device can include, but is not limited to, a thread protector, muzzle brake, or suppressor. The adjustable tuning device can be made of solid or semi-solid materials including rubber, plastic or plastic-like materials, steel, aluminum, and titanium. Finishes for the adjustable tuning device can include any coating type such as bare, painted, cerakote, anodized, and nitride.

[0025] It should also be appreciated that the adjustable tuning device is suitable for use with air rifles or other projectile launching devices. The adjustable tuning device can engage existing shroud threads, endcap threads, airstripper threads, muzzle brake threads, and suppressor mount threads in addition to muzzle threads and in alternative configurations may include a set of threads to be used for additional muzzle device attachments. The adjustable tuning device can replace the jam nut used by self-timing muzzle brakes or suppressor mounts, thereby reducing the overall length of the firearm while adding the ability to tune the firearm. The adjustable tuning device can be used in conjunction with an air rifle's existing barrel shroud endcap or airstripper, or replace the existing barrel shroud endcap or airstripper, to provide the ability to tune the air rifle. The

adjustable tuning device can also act as a barrel tensioning device when used for an air rifle, air rifle shroud, or combination thereof.

[0026] FIG. **7** illustrates an alternative embodiment of the improved adjustable tuning device **200** of the present invention. More particularly, FIG. **7** shows the alternative embodiment of the adjustable tuning device in use attached to the muzzle portion **104** of the barrel **102** of a firearm **100**, which is a rifle in the current embodiment. The alternative embodiment of the adjustable tuning device **200** has a cup **202** having a base **204** defining a threaded aperture **206**. The threaded aperture is configured to receive the muzzle portion **104** and a limited rear portion **126** of the muzzle device **120** such that a forward portion **114** of the muzzle portion does not extend forward of the base. Compared to the threaded aperture **16** of the cup **12**, the threaded aperture **206** of the cup **202** is enlarged to match the thread dimensions on the external diameter of a self-timing muzzle brake serving as the muzzle device **120**. This change enables the cup to replace and act as the reverse jam nut **122** on self-timing muzzle brakes. The cup has a rear surface **208** configured to abut the forward-facing shoulder **106** of the barrel **102**. The cup is externally threaded with external threads **210** and has a skirt **212** extending rearwardly of the base. The skirt defines an internal space **212** with a diameter **214** greater than the exterior profile **110** of the barrel, and is externally threaded with the external threads **210**. Depending on the characteristics of the host firearm, the cup may abut a barrel shroud or shroud endcap instead of the barrel shoulder, particularly in the case where the host firearm is an airgun.

[0027] The muzzle portion **104** of the barrel **102** is threaded with muzzle threads **116**. The threaded aperture **206** of the cup **202** mates with a threaded exterior portion **128** of the limited rear portion **126** of the muzzle device **120**. The threaded aperture of the cup has an internal diameter **220** sized such that the forward portion **114** of the muzzle portion is exposed to receive and connect to the internal threads **130** on the user-selected muzzle device **120**. In the current embodiment, the muzzle device is a muzzle brake, which is a separate muzzle device configured for attachment to the forward portion of the muzzle portion while the cup is threadedly attached to the limited rear portion **126** of the muzzle device. The cup has an optional flange **216** that is compressively captured between the muzzle device and the forward-facing shoulder **106** of the barrel. The flange has a forward-facing surface **218** configured to be abutted by the muzzle device connected to the forward portion of the muzzle portion.

[0028] A weight **32** has internal threads **34** configured to mate with the external threads **210** on the skirt **212** of the cup **202**. The weight is operable to move in a range of axial positions with respect to the cup along barrel axis **122** defined by the barrel bore **124** of the barrel **102**. In the current embodiment, the weight has a rear tapered portion **36** that tapers to a reduced internal diameter **38** at a rear end **40**. The reduced internal diameter accommodates barrels having an exterior profile **110** with a diameter of up to 1.08 inch approximately 2 inch behind the muzzle forward facing shoulder **106**. The taper helps maintain a closer fit to the barrel or shroud exterior profile to avoid catching the weight on barricades or external objects. However, it should be appreciated that the weight does not typically contact the barrel exterior profile. The cup has an external diameter **232** at the external threads **210**, and the reduced internal diameter of the weight at the rear tapered portion is less than the external diameter of the cup in the current embodiment. The weight has an open front end **44** configured to enable attachment of the muzzle device **120** to the muzzle threads **116** on the muzzle portion **104** of the barrel and to the threaded aperture **206** on the cup. In alternative embodiments, a smaller, non-tapered version of the weight can be used for hunting rifles, and a larger version of the weight can be used for larger barrel profiles and airgun shrouds.

[0029] There may or may not be gaps present between a muzzle device **120** that is a self-timing muzzle brake and the cup **202** or cup **12**. If the alignment works out perfectly, gaps would not be present. However, in most cases there would be gaps to time the muzzle brake correctly, and such gaps are shown in FIGS. **3-7**. It should also be appreciated that neither cup **202** nor cup **12** contacts the muzzle portion **104** of the barrel **102**.

[0030] In the context of the specification, the terms "rear" and "rearward," and "front" and "forward," have the following definitions: "rear" or "rearward" means in the direction away from the muzzle of the firearm while "front" or "forward" means it is in the direction towards the muzzle of the firearm.

[0031] While a current embodiment of an adjustable tuning device has been described in detail, it should be apparent that modifications and variations thereto are possible, all of which fall within the true spirit and scope of the invention. Although rifles have been disclosed, the adjustable tuning device is also suitable for use with a wide variety of firearms, including heavy contoured barrels designed for extended range or high rates of fire applications such as vehicle-mounted fire systems, track-mounted fire systems, ship-mounted fire systems, and airborne systems. Furthermore, the weight disclosed can be replaced with weights of different sizes or densities to provide the user with additional tuning options. The weight can have external markings to indicate rotational and axial movement. In addition, the threaded aperture of the cup can be any desired pitch to accommodate the muzzle threads of the host firearm and can also be used with a thread adapter to fit muzzle threads having a different pitch. With respect to the above description then, it is to be realized that the optimum dimensional relationships for the parts of the invention, to include variations in size, materials, shape, form, function and manner of operation, assembly and use, are deemed readily apparent and obvious to one skilled in the art, and all equivalent relationships to those illustrated in the drawings and described in the specification are intended to be encompassed by the present invention.

[0032] Therefore, the foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

I claim:

1. An adjustable tuning device for a firearm having a barrel with an muzzle portion, a forward-facing shoulder rearward of the muzzle portion, and a forward barrel portion rearward of the forward-facing shoulder and having an exterior profile, the device comprising:

a cup having a base defining an aperture configured to closely receive a limited rear portion of the muzzle portion such that a forward portion of the muzzle portion extends forward of the base;

the cup having a rear surface configured to abut the forward-facing shoulder;

the cup being externally threaded; and

a weight having internal threads configured to mate with the externally threaded cup and operable to move in a range of axial positions with respect to the cup.

2. The adjustable tuning device for a firearm of claim **1** wherein the cup has a skirt extending rearwardly of the base.

3. The adjustable tuning device for a firearm of claim **1** wherein the weight tapers to a reduced diameter at a rear end.

4. The adjustable tuning device for a firearm of claim **1** wherein the cup has an external diameter at an externally threaded portion, and wherein the weight has a rear portion having an internal diameter less than the external diameter of the cup.

5. The adjustable tuning device for a firearm of claim **1** wherein the muzzle portion of the barrel is threaded, and the cup aperture is threaded to mate with the muzzle portion.

6. The adjustable tuning device for a firearm of claim **5** wherein the cup base has a limited thickness less than half a length of the threaded muzzle portion such that a major portion of the muzzle portion is exposed to receive and connect to a selected muzzle device.

7. The adjustable tuning device for a firearm of claim **1** including a separate muzzle device configured for attachment to the forward portion of the muzzle portion while the cup is attached.

8. The adjustable tuning device for a firearm of claim **7** wherein the base of the cup is compressively captured between the muzzle device and the forward-facing shoulder.

9. The adjustable tuning device for a firearm of claim **1** wherein the cup base has a limited thickness less than a length of the muzzle portion such that a portion of the muzzle portion is exposed to receive and connect to a selected muzzle device.

10. The adjustable tuning device for a firearm of claim **1** wherein the cup base has a forward-facing surface configured to be abutted by a muzzle device connected to the forward portion of the muzzle portion.

11. The adjustable tuning device for a firearm of claim **1** wherein the cup base has a thickness of less than ¼ inch.

12. The adjustable tuning device for a firearm of claim **1** wherein the cup base has a thickness of less than the diameter of the aperture.

13. An adjustable tuning device for a firearm having a barrel with a threaded muzzle portion, a forward-facing shoulder rearward of the muzzle portion, and a forward barrel portion rearward of the forward-facing shoulder and having an exterior profile, the device comprising:

a cup having a base defining a threaded central aperture configured to mate with the threaded muzzle portion;

the base having a rear surface configured to abut the forward-facing shoulder of the barrel;

a skirt extending rearwardly from the base and defining an internal space with a diameter greater than the exterior profile of the barrel;

the skirt being externally threaded;

a weight having internal threads configured to mate with the externally threaded cup and operable to move in a range of axial positions with respect to the cup;

the weight having an open front end configured to enable attachment of a muzzle device forward of the cup base to the threaded muzzle portion of the barrel; and

the cup base having a limited thickness of less than the diameter of the aperture.

14. A firearm comprising:

a barrel with a threaded muzzle portion, a forward-facing shoulder rearward of the muzzle portion, and a forward barrel portion rearward of the shoulder and having an exterior profile;

a cup having a base defining an aperture configured to closely receive a limited rear portion of the muzzle portion such that a forward portion of the muzzle portion extends forward of the base;

the cup having a rear surface configured to abut the shoulder;

the cup being externally threaded;

a weight having internal threads configured to mate with the externally threaded cup and operable to move in a range of axial positions with respect to the cup; and

a muzzle device threadedly connected to the forward portion of the muzzle portion with the base of the cup captured compressively between the muzzle device and the forward-facing shoulder.

15. The firearm of claim **14** wherein the cup has a skirt extending rearwardly of the base.

16. The firearm of claim **14** wherein the weight tapers to a reduced diameter at a rear end.

17. The firearm of claim **14** wherein the cup has an external diameter at an externally threaded portion, and where the weight has a rear portion having an internal diameter less than the external diameter of the cup.

18. The firearm of claim **14** wherein the cup base has a limited thickness less than half a length of the threaded muzzle portion such that a major portion of the muzzle portion is exposed to receive and connect to a selected muzzle device.

19. The firearm of claim **14** wherein the cup base has a thickness of less than ¼ inch.

20. The firearm of claim **14** wherein the cup base has a thickness of less than the diameter of the aperture.

* * * * *