ABSTRACT OF THE DISCLOSURE

A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a body having a muzzle plate with a concave-surface facing away from the muzzle, a recoil plate with a concave surface facing the muzzle and spaced from the muzzle plate and an end plate having a curved surface also facing the muzzle and spaced from the recoil plate, and passageways through said plates for the passage of the bullet, dimensioned such that they are substantially closed to the flow of gases therethrough during the interval that the bullet is in the bore.

The present application is a continuation-in-part of my prior application Ser. No. 576,630, now abandoned, filed Sept. 1, 1966 for Recoil Controlling Devices.

This invention relates to recoil controlling devices or muzzle brakes adapted for attachment to gun barrels and particularly to a gas inertia controller particularly adapted for use with rifles, pistols, shotguns and similar small arms and which is designed to reduce recoil by utilizing the gases generated by the firing of the gun.

Generally, in prior art devices of this nature, the gases expelled from the gun muzzle were diverted and the forces created by the change in direction of the gases used to oppose the recoil force. However, most such prior devices merely diverted the gases radially around the gun-barrel axis, which also merely served to reduce recoil but in doing so greatly increased the amount of noise heard by the user.

In an attempt to reduce the noise problem, the present applicant and another developed the gas inertia controller shown in Patent No. 3,152,510. Such controller utilized two chambers, the first conical and the second cylindrical, through which the bullet passed and which controlled the flow of gases, with radial porting at the forward end of the conical chamber to allow outward venting of the gases somewhat in the forward direction to reduce the noise heard by the user. Although such controller was a substantial improvement on prior devices, the amount of noise it produced was still objectionable.

Accordingly, it is a primary object of this invention to provide a much improved recoil controlling device that not only diminishes recoil but also noise level far below that of heretofore known devices.

Another object is to provide an improved and reliable recoil controlling device capable of simple manufacture and which is of simple and rigid construction.

Still another object is to improve the accuracy of the firearm.

A further object is to reduce the intensity of the flash produced by the firing of the gun.

The above and still further objects of the present invention have been achieved by the establishment of a unique pattern of gas flow within the controller of the invention, wherein the gases are not simply caused to move radially, but, rather are, at least in part, first retroverted by effect turning the gas stream radially inwardly and back within itself so that the kinetic energy of the gas stream is to a large extent dissipated within the gas stream itself before it is allowed to pass radially outwardly from the controller.

More specifically, the gas inertia controller of the invention, like that of Patent No. 3,152,510, is used with a firearm having a predetermined bore and terminating at a muzzle and is mounted on the muzzle end of the firearm. It includes a casing having a recoil plate and preferably an end wall, the end wall being at the front end of the device and the recoil plate in between the muzzle plate and the end wall. The plate and the end wall are generally perpendicular to the axis of the muzzle. The casing thus preferably defines two chambers, a conical recoil control chamber of increasing cross-section area from the muzzle to the recoil plate, the axis of the conical chamber coinciding with the extended axis of the gun muzzle, and a cylindrical chamber between the recoil plate and the end wall. The cylindrical chamber may be provided with a port. The diameter of the conical chamber near the muzzle is about equal to the bore diameter.

The plate and end wall have apertures that form a passageway for the bullet fired from the gun.

Unlike the device of said patent, however, the device of the present invention, in order to create the unique gas flow pattern upon which its effectiveness depends, has its recoil plate and preferably its end wall provided with concavely curved surfaces. The curvature of the surfaces of the recoil plate and the end wall forces the escaping gases impinging on them to reverse and converge inwardly at the axis of the device. This convergence has the effect of compressing the reversed gases (an effect aided by the conical nature of the primary chamber). This gas flow opposes the flow of gases still escaping the gun barrel, absorbing much of their energy. A portion of the wall of the conical chamber adjacent the muzzle is provided with a port, with the forward portion of the device being partially or entirely enclosed to ensure the reverse gas flow characteristic of the invention. Thus the location of the port near the muzzle has the result that gases finally escaping by that route must have travelled to the recoil plate and then radially inwardly and back to near the muzzle. Optionally, the wall of the conical chamber may be provided with a second port, located forward of the port adjacent the muzzle.

In addition, the device of the present invention is provided with a muzzle plate, also preferably having a concave surface adjacent the muzzle end of the device which curved surface ensures that the gases escaping through the port adjacent the muzzle must take a forward component of velocity further to reduce noise. When the second port is present, a plate similar to the muzzle plate is also provided for the second port, performing the same function.

Other objects, features, and advantages will appear from the following description of preferred embodiments of the invention, taken together with the attached drawings thereof, in which:

FIG. 1 is an elevational view of a gas inertia controller, according to the invention, mounted on a gun barrel;
FIG. 2 shows the pattern of gas flow in the chambers of the device during the period just after a bullet is fired;
FIG. 3 is a cross-sectional view of the device taken along the line 3—3 of FIG. 4;
FIG. 4 is partially a longitudinal sectional view of the device shown in FIG. 1 and partially a side elevational view of the gun barrel as shown in FIG. 1;
FIG. 5 is a cross-sectional view of the device taken along the line 5—5 of FIG. 4;
FIG. 6 is a side elevational view showing a modification;
FIG. 7 is a longitudinal vertical sectional view of the device of FIG. 6;
FIG. 8 is a cross-sectional view taken along line 8—8 of FIG. 7; FIG. 9 is a cross-sectional view taken along line 9—9 of FIG. 7, and FIG. 10 is a cross-sectional view taken along line 10—10 of FIG. 7.

In the drawings is shown a gun barrel 10 on which the gas inertia controller 12 is mounted. The device 12 is secured to the necked down portion 14 of the barrel 10 by screws or other suitable well-known means.

The casing 16 forms the two chambers: the primary conical chamber 18 and the secondary, cylindrical chamber 20. The primary chamber 18 extends from the muzzle plate 22 to the recoil plate 24. The conical walls 28 of the primary chamber 18 define an angle of about 20° from the axis of the cone. The recoil plate 24 is spaced from the muzzle a distance at least three times the diameter of the barrel bore. The diameter of the muzzle plate 22 is about equal to that of the recoil plate 24.

The secondary chamber 20 extends from the recoil plate 24 to the end wall 26. The end wall 26 is spaced from the recoil plate 24 a distance about twice the bore diameter. The inner diameter of the wall 30 of the cylindrical chamber 20 is at least about twice and more preferably about three to four times the bore diameter.

There is a port 32 adjacent the muzzle 14 in the wall 28 of the primary, conical chamber 18. The port 32 is in the upper portion of the conical chamber wall 28 between lines on the wall 28 approximately on the same horizontal plane as the bottom of the bore of the gun barrel and between the surface of the muzzle plate 22 and a circumferential line approximately halfway between the muzzle plate 22 and the recoil plate 24.

The surface 34 of the muzzle plate 22 facing away from the muzzle 14 is curved in a concave fashion. The surface 36 of the recoil plate 24 facing the muzzle 14 is curved, in a cross-sectional view (see FIG. 4), concave from outer edge to aperture 38. The surface 40 of the end plate 26 is curved in a manner similar to the recoil plate surface 36. The end plate 26 has an aperture 42. The muzzle plate 22 is so constructed for mounting on the gun muzzle 14 that it, in effect, has an aperture 44. These apertures 38, 42 and 44 provide a passageway for the bullet. The length of the recoil plate aperture 38 is preferably about the same diameter of the bore and the diameter of the aperture 38 is slightly greater than that of the bore. The aperture 38 flares slightly toward the end plate 26 to facilitate the spreading of the gases. The end plate aperture 42 also has a diameter slightly greater than the diameter of the bore.

In operation, the explosion of the charge generates gases which push the bullet and the slug of air in front of the bullet out of the barrel 10. Some of the gases generated escape around the base of the bullet and travel ahead of it.

The gases leaving the barrel impinge on the recoil plate curved surface 36 and the end plate curved surface 40. They are reflected back and toward the axis of the chambers 18 and 20 (see FIG. 2). This convergence along the axis has the effect of compressing the gases. Compression is aided by the narrowing of the cavity of the conical chamber 18 as the reversed gases flow toward the muzzle 14. The compressed gases traveling back along the axis meet gases still escaping from the gun barrel 10 and absorb much of their energy.

While the bullet is traveling through the apertures 38, and 42, it pushes off an escape or gases in the preceding chamber. When the bullet is not in one of the apertures 38 and 42, that aperture provides a main exit for gases moving forward from the muzzle 14. The gases are reflected from the curved recoil plate surface 36 and the curved end wall surface 40 in such a manner that they converge on the axis and are there particularly effective in counteracting the movement of the forward gases because they oppose the movement of the forward gases in the area of their main escape route. The reflection and opposition of flowing gases in the chambers 18 and 20 of the device result in a less rapid discharge of the gases from the device.

The change in direction of the gases that results when they strike the surfaces 36 and 40 creates a force opposite to that of the recoil, thereby diminishing the recoil.

Because of the buildup of pressure in the chambers 18 and 20 of the device due to the reflection of the gases, when the bullet leaves from the barrel of the firearm, it enters a zone of intermediate pressure rather than a zone of substantially zero pressure as is the case where no gas inertia controller is being used. The bullet becomes spin stabilized much more rapidly, with resulting increased accuracy.

As the bullet moves into the aperture 38 there is a significant increase of pressure in the primary chamber 18 since a portion of substantial area is then closed. As the bullet leaves the recoil plate aperture 38, pressure will build up in the enclosed cylindrical chamber and so further delay the release of gases. During the entire operation, however, gases are gradually but continually being released through the port 32. Because the port 32 is near the muzzle 14 the gases leaving through the port will have traveled to the recoil plate surface 36 or the end plate surface 40, being reflected from them and then from the walls of the chambers 18 and 20 while moving back to the port 32. The gases thus spend some time in the device before exiting.

The curvature of the muzzle plate surface 34 results in the gases leaving through the port 32 having a tendency to move forward, away from the gun user, and hence, diminishing the noise level apparent to him.

The successive discharge of gases from the two successive chambers 18 and 20, one ported and the other enclosed, over a comparatively extended period of time reduces the magnitude of sound and also the temperature of the gases, which in turn tends to reduce the volume of gas by cooling, so that the flash is sharply reduced.

The modification of FIGS. 6–10 is in general organization similar to the device of FIGS. 1–5 described above. It is mounted on the gun barrel 10 as shown. It includes a primary, conical chamber 46, a cylindrical chamber 48 and, forwardly of the cylindrical chamber 48, a flash hider 50. The end plate 52 which forms the forward wall of the cylindrical chamber 48 is provided with an annular groove 54 whereby the end plate is curved in a concave fashion, being concave toward the gun muzzle. The groove 54 is optional and may be omitted. The cylindrical end wall 56 of the cylindrical chamber 48 is provided with a gas discharge port 58, in the form of a slot disposed at right angles to the axis of the device. As shown, the port 58 extends across the top of the device and extends further down on the right side than it does on the left, thus directing discharged gases upwardly and to the user's right, thus serving to counteract any tendency of the barrel to move upwardly when fired and also counteracting any tendency of the barrel to move to the right, as during automatic fire. The port 58 is spaced rearwardly of the concave surface 54 and thus possesses to some extent the advantages as to location described above in connection with the port 32. The port 58 is an optional feature and may be omitted. The aperture 60 at the forward end of the cylindrical chamber 48 is similar in structure and function to the aperture 42 previously described.

The primary, conical chamber 46 is provided with a port 62 corresponding to the port 32 previously described. A muzzle plate 64 having a concave forward surface 66 corresponds to the muzzle plate previously described. A rib 68 extending across the port 62, as shown, reinforces the structure at this point. The recoil plate 70 with its aperture 72 and its rearwardly concave surface at 74 corresponds to the recoil plate 24 previously described.

In this modification, a gas-discharge port 76 is provided at the forward end of the primary, conical chamber 46.
shaped, as shown to best advantage in FIG. 9, to discharge upwardly and to the user's right. A deflector plate 78 having a concave forward face 80 is provided adjacent and rearwardly of the port 76, functioning like the muzzle plate portion to guide muzzle plate and to project upwardly to the user. A rib 82 reinforces the structure at this point. Other modifications of the disclosed structure (e.g. varying the pressure buildup by varying the passageway length or varying the area of the port) will be obvious to those having ordinary skill in the art.

What is claimed is:

1. A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion with a concavely curved surface facing the muzzle, and an end plate portion with concavely curved surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body in axial alignment with the barrel of the firearm for the passage therethrough of the bullet, said passageway being defined by a rear cylindrical bore disposed in said muzzle plate portion adapted to be secured to the muzzle end of said firearm and a substantially cylindrical bore disposed in said recoil plate portion being dimensioned such that said recoil plate cylindrical bore is substantially closed to the flow of gases therethrough during the interval that the bullet is in said recoil plate cylindrical bore, a cylindrical bore disposed in said end plate portion having a diameter sufficient to permit free passage of the bullet therethrough but being dimensioned such that the end plate is substantially closed to the flow of gases therethrough during the interval that the bullet is in said end plate bore, a conical chamber intermediate said recoil plate and said end plate portions, the interior wall of said conical chamber being disposed at an angle to said longitudinal axis so that the cross-sectional area of the chamber increases at a substantially uniform rate from said muzzle plate to said recoil plate, said chamber being substantially enclosed throughout its length and having at its end adjacent said muzzle plate peripheral port means extending through the wall of said chamber and for a portion of the length of said conical chamber along said axis, and an enclosed cylindrical chamber intermediate said recoil plate and said end plate portions, whereby gases expelled from said muzzle move past a bullet within said chambers, strike the concave surface of said recoil plate within the enclosed forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and said port as said bullet is passing through said recoil plate bore, and strike the concave surface of said end plate within the enclosed said cylindrical chamber and are diverted inwardly and back toward said muzzle and said port as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they pass outwardly through said port, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port.

2. The apparatus of claim 1 in which the cross-sectional area of the chamber increases at a substantially uniform rate from said muzzle plate portion to said recoil plate portion.

3. A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion of substantial thickness with a concavely curved surface facing the muzzle and an end plate portion with a concavely curved surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body in axial alignment with the barrel of the firearm for the passage therethrough of the bullet and the gases expelled from the muzzle upon explosion of the charge, said passageway being defined by a rear cylindrical bore disposed in said muzzle plate portion adapted to be secured to the muzzle end of said firearm, a substantially cylindrical bore disposed having a diameter sufficient to permit free passage of the bullet therethrough but being dimensioned such that the recoil plate cylindrical bore is substantially closed to the flow of gases therethrough during the interval that the bullet is in said recoil plate cylindrical bore, a cylindrical bore disposed in said end plate portion having a diameter sufficient to permit free passage of the bullet therethrough but being dimensioned such that the end plate is substantially closed to the flow of gases therethrough during the interval that the bullet is in said end plate bore, a conical chamber intermediate said recoil plate and said end plate portions, the interior wall of said conical chamber being disposed at an angle to said longitudinal axis so that the cross-sectional area of the chamber increases at a substantially uniform rate from said muzzle plate to said recoil plate, said chamber being substantially enclosed throughout its length and having at its end adjacent said muzzle plate peripheral port means extending through the wall of said chamber and for a portion of the length of said conical chamber along said axis, and an enclosed cylindrical chamber intermediate said recoil plate and said end plate portions, whereby gases expelled from said muzzle move past a bullet within said chambers, strike the concave surface of said recoil plate within the enclosed forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and said port as said bullet is passing through said recoil plate bore, and strike the concave surface of said end plate within the enclosed said cylindrical chamber and are diverted inwardly and back toward said muzzle and said port as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they pass outwardly through said port, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port.

4. A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion with a concavely curved surface facing the muzzle, and an end plate portion with a concavely curved surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body in axial alignment with the barrel of the firearm for the passage therethrough of the bullet, said passageway being defined by a rear cylindrical bore disposed in said muzzle plate thereby gases expelled from said muzzle move past a bullet within said chamber, strike the concave surface of said recoil plate within the enclosed forward portion of said chamber and are diverted inwardly and back toward said muzzle and said port as said bullet is passing through said recoil plate bore substantially to dissipate the kinetic energy of said gases before they pass outwardly through said muzzle plate's concavely curved surface giving a forward component of velocity to gases leaving the apparatus via said port.

5. The apparatus of claim 4 in which the cross-sectional area of the chamber increases at a substantially uniform rate from said muzzle plate portion to said recoil plate portion.

6. A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion with a concavely curved surface facing the muzzle,
and an end plate portion with a surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body in axial alignment with the barrel of the firearm for the passage therethrough of the bullet and said passageway being disposed parallel to the longitudinal axis of said body, a rear cylindrical bore disposed in said muzzle plate portion adapted to be secured to the muzzle end of said firearm and a substantially cylindrical bore disposed in said recoil plate being dimensioned such that said recoil plate substrate is substantially close to the flow of gases therethrough of the bullet and having a port therein, whereby gases expelled from said muzzle move past a bullet within said conical chamber, strike the concave surface of said recoil plate within the forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said recoil plate bore, and strike the surface of said end plate within the said cylindrical bore and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they leave the controller, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port means.

8. A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion with a concavely curved surface facing the muzzle and an end plate portion with a surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body in axial alignment with the barrel of the firearm for the passage therethrough of the bullet, said passageway being disposed parallel to the longitudinal axis of said body, a rear cylindrical bore disposed in said muzzle plate portion adapted to be secured to the muzzle end of said firearm and a substantially cylindrical bore disposed in said recoil plate being dimensioned such that said recoil plate substrate is substantially close to the flow of gases therethrough of the bullet and having a port therein, whereby gases expelled from said muzzle move past a bullet within said conical chamber, strike the concave surface of said recoil plate within the forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said recoil plate bore, and strike the surface of said end plate within the said cylindrical bore and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they leave the controller, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port means.

9. A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion with a concavely curved surface facing the muzzle and an end plate portion with a surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body in axial alignment with the barrel of the firearm for the passage therethrough of the bullet, said passageway being disposed parallel to the longitudinal axis of said body, a rear cylindrical bore disposed in said muzzle plate portion adapted to be secured to the muzzle end of said firearm and a substantially cylindrical bore disposed in said recoil plate being dimensioned such that said recoil plate substrate is substantially close to the flow of gases therethrough of the bullet and having a port therein, whereby gases expelled from said muzzle move past a bullet within said conical chamber, strike the concave surface of said recoil plate within the forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said recoil plate bore, and strike the surface of said end plate within the said cylindrical bore and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they leave the controller, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port means.
end plate is substantially closed to the flow of gases therethrough during the interval that the bullet is in said end plate bore, a conical chamber intermediate said muzzle plate and recoil plate portions, the interior wall of said conical chamber being disposed at an angle to said longitudinal axis so that the cross-sectional area of the chamber increases at a substantially uniform rate from said muzzle plate to said recoil plate, said chamber having at its end adjacent said muzzle plate periphery, and for a portion of the length of said conical chamber along said axis, said chamber having a second port means extending through the wall of said chamber and for a portion of the length of said conical chamber along said axis, said second port being located forwardly of said port means, a deflector plate having a forwardly concave face located adjacent and rearwardly of said second port means, and a cylindrical chamber intermediate said recoil plate and end plate portions, whereby gases expelled from said muzzle move past a bullet within said conical chamber, strike the concave surface of said recoil plate within the forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and said port means as said bullet is passing through said recoil plate bore, and strike the surface of said end plate within the said cylindrical chamber and are diverted inwardly and back toward said muzzle and in said port means as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they leave the controller, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port means.

A gas inertia controller adapted for attachment to the muzzle end of a firearm comprising a generally annular body having a muzzle plate with a concavely curved surface facing away from the muzzle, a recoil plate portion of substantial thickness with a concavely curved surface facing the muzzle and an end plate portion with a surface facing the muzzle spaced from said recoil plate, said plates being disposed perpendicularly to the longitudinal axis of said body, a passageway through said body adapted to be positioned in axial alignment with the barrel of the firearm for the passage there-through of the bullet and the gases expelled from the muzzle upon explosion of the charge, said passageway being defined by a rear cylindrical bore disposed in said muzzle plate portion adapted to be secured to the muzzle end of said firearm, a substantially cylindrical bore disposed in said recoil plate having a diameter sufficient to permit free passage of the bullet therethrough but being dimensioned such that the recoil plate cylindrical bore is substantially closed to the flow of gases therethrough during the interval that the bullet is in said recoil plate cylindrical bore, a bullet disposed in said end plate portion having a diameter sufficient to permit free passage of the bullet therethrough but being dimensioned such that the end plate is substantially closed to the flow of gases therethrough during the interval that the bullet is in said end plate bore, a conical chamber intermediate said muzzle plate and recoil plate portions, the interior wall of said conical chamber being disposed at an angle to said longitudinal axis so that the cross-sectional area of the chamber increases at a substantially uniform rate from said muzzle plate to said recoil plate, said chamber having at its end adjacent said muzzle plate periphery, and for a portion of the length of said conical chamber along said axis, said second port being located forwardly of said port means, a deflector plate having a forwardly concave face located adjacent and rearwardly of said second port means, and a cylindrical chamber intermediate said recoil plate and end plate portions, whereby gases expelled from said muzzle move past a bullet within said conical chamber, strike the concave surface of said recoil plate within the forward portion of said conical chamber and are diverted inwardly and back toward said muzzle and in said port means as said bullet is passing through said end plate bore, substantially to dissipate the kinetic energy of said gases before they leave the controller, said muzzle plate's concavely curved surface giving a forward component of velocity to said gases passing through said port means.

References Cited

FOREIGN PATENTS
233,709 1/1926 Great Britain.

BENJAMIN A. BORCHELT, Primary Examiner
STEPHEN C. BENTLEY, Assistant Examiner

U.S. Cl. X.R.

181—57