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MEMORANDUM
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AUGUST 1968

BINARY CODED GUN BARRELS TO
DISCOURAGE ILLEGAL USE OF
SMALL ARMS

Paul Baran

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PREFACE

This Memorandum is in response to an informal request from the President's Task Force on Violence for information relative to the technical feasibility of gun detection.

The proposal herein does not specifically address the question of gun detection but describes a scheme for identifying a gun from an expended bullet recovered intact.

SUMMARY

This Memorandum proposes a scheme by which each hand-gun and rifle in the country is modified so that its gun barrel leaves a predetermined tracing on all bullets fired. This tracing would be read as a unique binary-coded number corresponding to the serial number of the gun.

ACKNOWLEDGMENTS

R. N. Reinstedt chaired an "experimental brainstorming session" during the summer of 1967 in which a group of summer students at RAND were asked to consider new approaches to reducing crimes. One suggestion made by Reinstedt at this meeting was to keep records of the marks left upon bullets by the barrel rifling of each gun. This Memorandum is an extension of his basic idea.

I would further like to acknowledge the many useful ideas suggested by H. Steingold, B. West, R. Reinstedt, and E. Martinelli, all of whom reviewed this Memorandum.

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I. INTRODUCTION

At least one in every two hundred deaths in the United States is a homicide. The misuse of small arms has caused a storm of protests and demands for gun registration. For every successful assassination there are many misses-- bullets fired into homes and cars of politically prominent figures. Unsuccessful assassins (or intimidators) are rarely caught.

Registration will keep some guns out of the hands of known irresponsibles. But even with gun registration we will still have the many *unknown* immature gun owners who fire at road signs in the desert; at passing cars; at light-posts; and, occasionally, at political figures.

Would it be possible to indelibly mark each bullet with the registration number of the firing gun and keep up-to-date records on gun ownership? And, would this help discourage the irresponsible use of guns with minimum loss of rights to the more legitimate users? In particular, is this notion sufficiently technically feasible to warrant further consideration?

When a gun is fired, the soft metal of the bullet is viscously deformed against the hard steel spiral grooves of the gun barrel. The spiral grooving imparts a gyroscopic spin to the bullet to improve the uniformity of its trajectory. The marks left on bullets are the impressions of the details of the steel rifling surface. These vary from gun to gun.

These marks, as distinctive as fingerprints, have often been used to match a spent bullet with a particular gun barrel. But today you need the gun for comparison. Matching a bullet against *all* of the possible tens of millions of guns of the same caliber is not, at this time, economically feasible. We seek to make this task less formidable.

II. THE PROPOSAL

1) Scribe each gun barrel so that it will leave a *predetermined*, standardized, coded marking on each fired bullet.

2) Code the markings in a binary fashion uniquely corresponding to the serial number inscribed on the gun barrel.

3) Given the above, a spent bullet--if not excessively damaged--will be indelibly scribed with the weapon's serial number.

4) A central registration file of guns ordered by serial numbers would indicate the following:

- a) the name and address of the present registered owner;
- b) whether the gun was stolen (if so, when and under what circumstances).

5) The maximum use of this information implicitly presupposes a gun registration law with periodic inspection reviews.

6) At every weapon registration renewal (or spot check), the weapon would be examined to insure that it is well maintained and safe to use. (For safety reasons, guns in poor mechanical condition would not be registered until suitable repairs were made. Defective guns could be rendered permanently inoperative and/or otherwise removed from circulation.)

7) After the preliminary inspection each gun would be fired into a viscous braking medium (e.g., water) to slow the bullet without damage. The bullet markings would then be read to insure that they are

- a) clearly visible;
- b) match the legal registration number.

8) All bullets found near a "scene of the crime" would be examined to determine gun identity. Next, the suspect weapon would be checked to insure that *fine-grain* scratches also match, thus guarantying that the scribings have not been counterfeited.

III. WHAT IS TO BE GAINED?

The number of bullets fired by irresponsible persons is much greater than the number of people killed by such persons. Those misusing weapons could be better traced and controlled. For example, consider the following cases where persons would be less inclined to fire coded weapons in an antisocial manner.

1) *Riots*--Which gun fired each bullet that ended where? (Was it fired by a possible sniper or was it fired by Policeman Jones or Policeman Smith or National Guardsman Doe?)

2) *Intimidations*--Which gun was used by a nightrider to fire bullets into a civil rights worker's house?

3) *Assassination Attempts*--Not all assassination attempts are successful. Remember the case of General Walker and the difficulty that could have been avoided had the would-be assassin been caught.

4) *Malicious Mischief*--Which gun was used to pepper road signs?

5) *Reckless Hunters*--Bullets removed from farmer Brown's cow might tell us which gun fired the bullet. Hunters who shoot one another are often unaware that they have hit a human. Bullets removed from hapless bystanders would provide very useful information to the lawyers of the next-of-kin, and to investigating officers.

IV. OBVIOUS PROBLEMS

1) We do not know the number of guns in this country. Estimates range as high as one gun for every man, woman and child. To register all is nearly impossible.

2) A black market is created for unmarked guns.

3) We increase the value of a stolen gun, and encourage more thievery.

4) The proposed scheme will not work for shotguns.

5) Some bullets deform on impact with tissue. Some disintegrate on impact. Only those bullets that are recovered in reasonably intact condition will be readable.

6) The burden of proof falls upon the proponents of this scheme that gun accuracy will not be impaired.

7) Assume a population of 50,000,000 guns, an initial cost of \$5 to scribe each gun, and \$1 annually for inspection (these numbers are sheer guesses). This means an initial cost of \$250,000,000 to code all guns plus another \$50,000,000 per year to keep track of them.

8) The nuisance of checking guns annually could cost votes in rural areas and may make this idea politically unacceptable.

9) The logistics of implementing this program are complex and need more examination.

10) Guns with easily interchangeable barrels would require special consideration (e.g., the widely issued U.S. Government Model 1911 and 1911A1 .45 caliber automatics).

V. METHOD OF ACCOMPLISHMENT

Is the proposal feasible?

The record keeping task can probably be handled via the internettted FBI computer system. For example:

Memory Requirements: Assumptions

100,000,000 guns = 10^8

100 coded words (average) per record = 10^2

8 bits/character

6 characters including space per word

= $10^8 \times 10^2 \times 8 \times 6$

= 4.8×10^{11} bits.

This means about 48 reels of old-fashioned magnetic tapes. (Better storage media are being developed.) As the information storage and search is *ordered by serial numbers* only a small computer having as few as two tape drives could be used for the central file. Manual tape exchange could be used for specific searches if desired.

SCRIBING BINARY NUMBERS ON GUN BARRELS

Gun barrels generally contain from two to six fluted lands. All engraving must be limited to the land area. A spiral ramrod that closely mates with the barrel rifling could be used. At the end of this special ramrod would be an assembly containing a series of movable scribe points which could be adjusted to form the desired binary pattern. Figure 1 shows a sketch of the ramrod and the scribing points. Each scribing point is fastened to a small cylindrical pin. Each cylindrical pin is emplaced in a separate hole passing diagonally through the end of the ramrod. The pins with their scribing points are shorter than the diameter of the ramrod. The thermal coefficients of expansion of the

Fig. 1--Method to Set Up Device for Scribing Gun Barrels
with Predetermined Binary-Coded Patterns

pins and the ramrod end are chosen so that when the ramrod is chilled (or heated) the pins may be slid a short distance through their mounting holes. The pins may be set up automatically by use of a device comprising:

- 1) A set of digital decimal switches to insert the serial number of the gun;
- 2) An electronic code-conversion circuit to translate the decimal number into a suitably coded binary pattern;
- 3) A driver circuit to actuate a pair of solenoids;
- 4) Means for rotating and advancing the ramrod so that each pin is sequentially adjusted into one of two positions: either protruding a fixed distance, or totally inserted into its hole.

Restated: The serial number of the gun is set up on decimal switches. This operates a device that moves all the scribing pins in or out, corresponding to the coded number. The ramrod is then heated (or chilled) so that the pins are locked into position. The ramrod then can be used to scribe a fine-line pattern inside the gun barrel. This uniquely codes all bullets emerging from the gun with its serial number.

Separate ramrods would be required for each caliber and pitch. Gun registration periods could be timed so that all guns of a given caliber and pitch are scheduled for inspection in an area during the same period. This would allow a small number of these special ramrods for all common gun models without requiring an extremely large ramrod inventory at any one gun inspection station.

While a simple decimal-to-binary conversion can be used for the code patterns, an "error correcting code" would be advantageous. This would insure readability of the numbers in the event of one, two, or three disfigured scribing lines.

Diamonds, sapphires, or even tungsten carbide will easily scratch steel without excessive wear. After the scribing, a smoothing reamer can remove any rough edges.

Without extensive testing, no guarantees can be made against reduced weapon accuracy; but it does not seem likely that any significant loss of accuracy would occur in guns so treated.

An alternative way to code new guns would be to modify the width and positioning of the lands from barrel to barrel. For example, assume six lands in a gun barrel whose width can be varied 27 percent, and whose manufacturing tolerances can be kept to within 1 percent. The number of land-width coded combinations equals $25^6 \div 6$. (The reason for the " $\div 6$ " is that the location of the first digit is ambiguous.)

$$25^6 \sim 2.44 \times 10^8$$

$$25^6 \div 6 \sim 4.18 \times 10^7$$

This means that over 41 million combinations are possible for a single caliber and a single number of lands--assuming necessary changes in manufacturing technology. At present a series of broaches is usually used to progressively deepen the grooves. The scheme proposed would require adjustable or multi-part broaching of gun barrels.

VI. CAVEATS

This Memorandum is a brief discussion of an idea.

Before any further commitment is made, experimental verification of the notion is required. Such testing should determine which classes of guns are not suitable for the proposed marking scheme.

Such tests may also suggest modifications of the proposal that could make it more broadly applicable.

Further study is required to determine the best way of coding the serrated rifling of some .22 caliber weapons.

The numbers of guns involved and a precise cost estimate is yet to be determined.

The problems of wear and corrosion between inspections need field study.

Throughout this discussion it is implicitly assumed that triangular grooves are scratched along the entire length of the gun barrel deeper than the fine fortuitous scratching of the normal barrel finish. But better specifications of scratch depths, location, and codes are needed. For example, the form of redundant coding may have to be changed depending upon the form of gun barrel used. More data is needed.