

[54] **IMPLOSION COLORED MARKER**

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy**

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[51] Int. Cl.F42b 13/44

[58] Field of Search239/2, 14; 102/1, 2, 6, 6.6, 102/90; 199/85, 24, 27

[56] **References Cited**

UNITED STATES PATENTS

103,477 5/1870 Link102/66

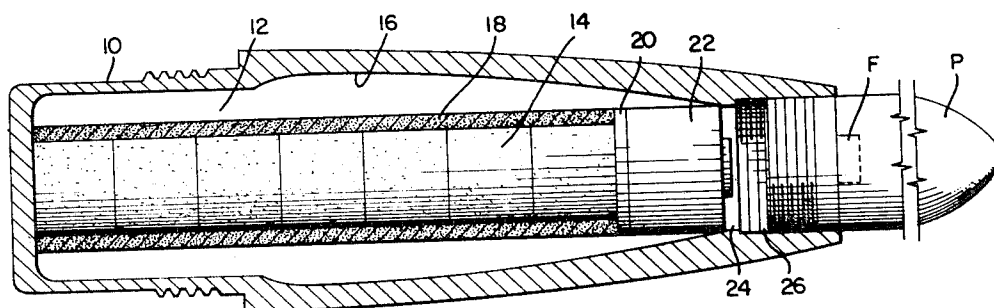
3,570,401	3/1971	Euker.....	102/6
3,505,957	4/1970	Tichauer et al.	102/6
2,974,596	3/1961	Allen.....	102/27 X
1,287,372	12/1918	McGaw.....	102/66
2,995,526	8/1961	De Ment.....	149/85 X
3,441,214	4/1969	Davienon et al.	239/2
3,472,165	10/1969	Null.....	102/2 X

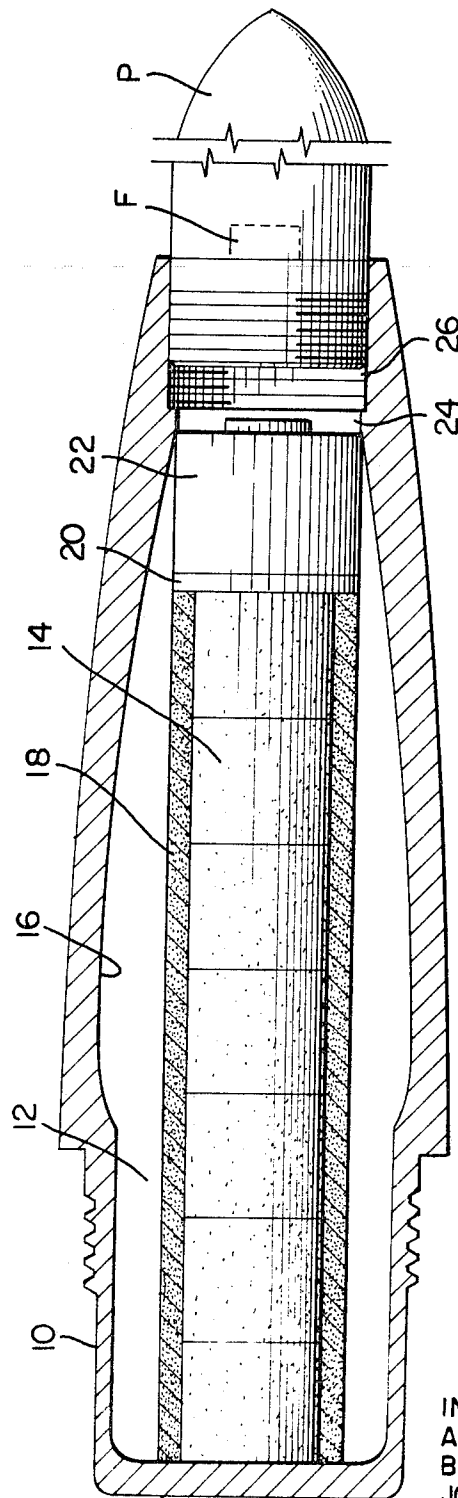
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[57] **ABSTRACT**

Implosion type colored marker for use by military personnel, comprising non-carcinogenic dyes either surrounded by or incorporated within a rock salt composition, such that, upon ignition of an explosive exteriorly the dye, the latter will condense upon minute salt particles caused to be dispersed into the atmosphere to form a colored cloud.

13 Claims, 2 Drawing Figures





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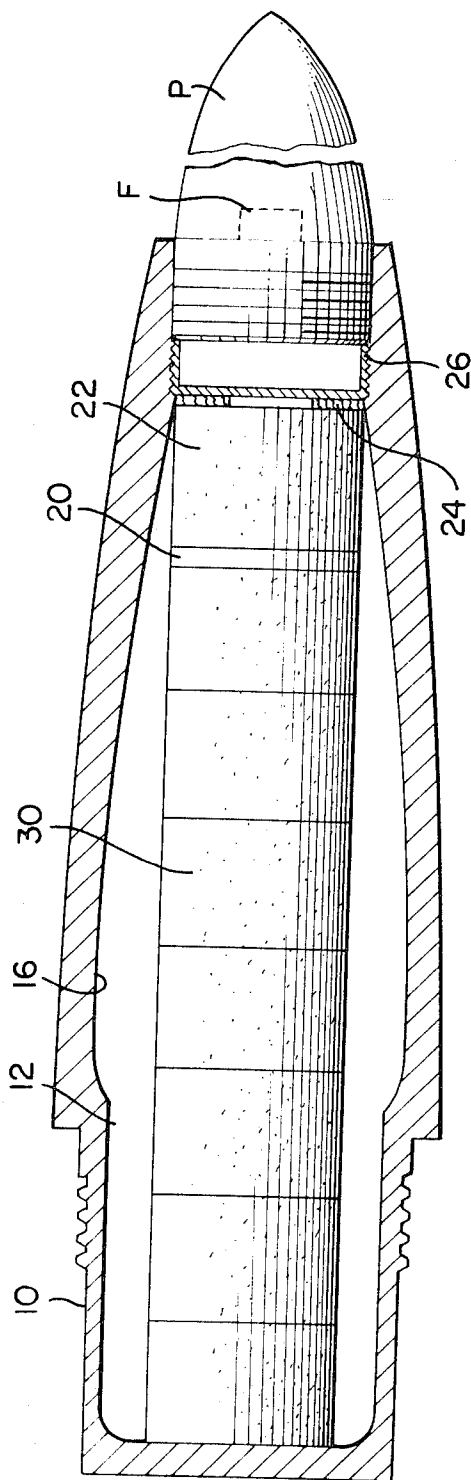


Fig. 2

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IMPLOSION COLORED MARKER

The invention described herein may be manufactured, used and licensed by or for the Government for governmental purposes without the payment to us of any royalty thereon.

This invention relates to pyrotechnics and more particularly concerns improved colored markers.

Colored markers are items of ammunition used in military operations for marking target areas and drop zones and for purposes of signalling by producing colored smoke clouds in designated areas.

The prior art methods of performing these functions were accomplished in the main, by explosion type colored markers.

In this type marker, the dyes which impart the desired colors are melted in any suitable heating unit and about 20 percent by weight of a very fine salt added thereto for forming a molten mix which is then cast into a shell body and allowed to solidify. A central cavity is then drilled into the dye, the cavity being filled with Baratol explosive, which consists of $67\% \pm 1\%$ barium nitrate and $33\% \pm 1\%$ of 2,4,6-trinitrotoluene (TNT).

A booster pellet is placed atop the Baratol charge and then a closing plug and fuze assembled to the shell. Upon firing, the fuze associated with the colored marker projectile arms in flight and initiates on impact with the target to initiate the booster pellet, which, in turn, detonates the core of Baratol explosive. The Baratol explodes outwardly, sublimating the dye and rupturing the shell body. The salt intermixed with the dye absorbs some of the heat of explosion, thus preventing a substantial portion of the dye from reaching its decomposition temperature. Additionally, the salt is dispersed into the atmosphere to provide nuclei upon which the sublimed dye may condense.

The explosion type colored markers aforescribed are capable of providing three colors only, i.e., red, yellow and green.

The red and yellow dyes could be melted directly while the green is produced by mixing powdered blue dye to molten yellow dye. The melting point of the blue dye is higher than the decomposition temperature of the yellow dye. The melting points of the red and yellow dyes are 170° and 115°C respectively. It is apparent that processing temperatures are critical since an excessive temperature would result in decomposition of the dyes. Further, in the molten states, these dyes yielded toxic fumes. The yellow dye (dimethylaminoazobenzene) is carcinogenic, and requires special safety equipment to prevent its exposure to the operator. The high temperatures involved are also hazardous to the operator. The addition of salt to the molten dye mix poses another problem since the density differential between the salt and the dye, and also the low viscosity of the molten dye, tends to allow the salt to settle to the bottom of the shell resulting in the upper portion of the dye in the shell being unprotected from the heat of explosion. On explosion, therefore, a large portion of this dye will be decomposed rather than sublimed.

Another deficiency of the explosion type marker is its inability to maintain a good visible cloud for extended periods, thus limiting its usefulness as a marker.

It is therefore a broad object of the instant invention to provide a pyrotechnic colored marker which sub-

stantially overcomes the disadvantages of explosion type colored markers aforescribed.

Another object of the invention is to provide an implosion type colored marker which incorporates dyes therein having non-critical melting points.

Still another object of the invention is to provide an implosion colored marker capable of yielding colored clouds of persistent duration and colors of greater diversity than heretofore achieved.

A further object of the invention is to provide colored markers having no carcinogenic compounds therein, is more economical and simpler to fabricate than the explosion type marker and yet providing greater lethality due to the amount of explosive capable of being carried therein.

A still further object of the invention is to provide an implosion colored marker wherein the amount of dye used is held to a minimum.

Other objects and many of the intended advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts and wherein:

FIGS. 1 and 2 illustrate respectively transverse sectional views of an embodiment and modification thereof of our invention.

Referring to the drawings, our implosion colored marker comprises a metal shell 10, that shown representing a 2.25 rocket warhead, the invention obviously not being limited thereto. The shell, having the usual projectile or warhead P and Fuze F associated therewith, serves a dual purpose:

1. To function as the vehicle in delivering the colored marker to the target area, and
2. To provide lethal fragmentation on detonation of the explosive charge.

The explosive charge is shown at 12 and most suitably will be Baratol, a standard military explosive. The main function of the Baratol is to explode shell 10 outwardly as fragmented parts and to provide heat by implosion to sublime dye pellets 14, to be described hereinafter.

Interior of shell 10 is coated with a bituminous compound 16, or priming paint, and functions to prevent undesirable interaction between explosive 12 and the metal shell 10 on long term storage. Bituminous compound 16 is an acid-proof black coating compound consisting of one or more grades of natural or petroleum asphalt in a low boiling, fast evaporating aliphatic naptha, and shall contain no drying oils, resins or pigments.

A film of the coating compound shall withstand immersion in distilled water without blistering, whitening, or softening and no more than a slight dulling, and shall withstand the action of picric, sulfuric, nitric and hydrochloric acids without disintegration, browning or dulling. There shall be no etching of the metal underneath coating compound.

The priming paint for ammunition will conform to MIL-S-22332 (Wep), 20 Nov. 1961.

Baratol is prepared by melting TNT in an agitator type steam jacketed kettle. Barium nitrate is added to the molten TNT and the resultant explosive agitated until a homogeneous mix is attained. The molten

resultant explosive is then cast into shell body 10. A central axial cavity is formed in the Baratol explosive by means of a suitable forming tool or by drilling. The explosive cavity is coated with the bituminous compound or priming paint aforescribed to prevent any interaction of dye 14 and Baratol 12 on long term storage.

Salt cylinders 18 consisting of $97.5 \pm 1\%$ rock salt and $2.5\% \pm 1\%$ stearic acid surround the central column of dye pellets as shown and additionally act as a heat sink in absorbing a portion of the heat of explosion of the Baratol. The heat barrier formed by the salt cylinders allows the dye to reach its sublimation temperature but prevents the dye from reaching its decomposition temperature. In addition, the salt particles from the salt cylinders are dispersed into the atmosphere upon explosion of the Baratol to provide nuclei upon which the sublimated dye condenses.

Rock salt shall meet the requirements of MIL-S-2072, 28 Feb. 1950, and the stearic acid should comply with MIL-S-271B, 25 May 1952.

Salt cylinders 18 may be manufactured by pulverizing the rock salt to a particle size of 45 ± 15 microns and then blending in the stearic acid as a binder. The resultant material will then be processed through an automatic pelleting press to yield a salt cylinder having a loading density of about 1.80 to 2.00 gm/cm³.

Data for our dye pellets 14 are presented in Table I below:

TABLE I.—DYE DATA

Smoke marker, color	Composition	Weight percent	Complying with MIL spec	MIL spec, dated
Red.....	1-methylaminoanthraquinone..... Stearic acid.....	95±1 5±1	PA-PD-382 (Rev. 1) (Pending revision of MIL-D-3284) MIL-S-271B.....	14 December 1955. 25 May 1962.
Yellow.....	Dye, vat yellow 4..... Benzanthrone..... Stearic acid.....	75±2 20±2 5±1	MIL-D-50029B..... MIL-D-50074B..... MIL-S-271B.....	15 July 1963. 1 July 1963. 25 May 1962.
Blue.....	1,4-dimethylaminoanthraquinone..... Stearic acid.....	95±1 5±1	PA-PD-313..... MIL-S-271B.....	31 July 1953. 25 May 1962.
Green.....	1,4-dimethylaminoanthraquinone..... Dye, vat yellow 4..... Benzanthrone..... Stearic acid.....	42±1 40±1 13±1 5±1	PA-PD-313..... MIL-D-50029B..... MIL-D-50074B..... MIL-S-271B.....	31 July 1953. 15 July 1963. 1 July 1963. 25 May 1962.

Explosion of Baratol 12 forms heat to sublimate dye pellets 14. The sublimated dye is dispersed into the atmosphere, the dye vapors condensing on the salt particles to result in an improved smoke cloud.

By employing an implosion technique, i.e., the explosive surrounds the dye rather than the dye surrounding the explosive as inheres in the typical explosion colored markers, the dyes may be pelleted or made into cylinders and obviates the necessity of melting and pouring the dye into the shell. Toxic fumes are thereby eliminated as well as danger of accidentally igniting the explosive. Additionally, the amount of dye needed in our implosion type colored markers is only about one third the amount required in explosion type markers, thus indicating an optimum utilization of our dyes.

Our dye pellets are manufactured by blending the specific dye with stearic acid and adding alcohol or

ether as a solvent, until a mix of putty-like consistency is achieved. The alcohol or ether solvents dissolve the stearic acid, insuring uniform dispersion throughout the mix. The materials are blended and the solvents driven off until a mix of extrudable consistency is attained. The dye-blend is then extruded through a perforated die to form spaghetti-strands thus facilitating drying of the dye-blend and increasing the bulk density of the material. The resultant material is dried and then granulated to a particle size which allows free flow in the hopper and dye of the pelleting press. The dye-blend is pelleted to a density of about 1.10 to 1.20 grams per cubic centimeter.

The salt cylinders-dye column is assembled by inserting dye pellet 14 into the salt cylinders 18, stacking one dye pellet on top of another until the desired height of the dye column is attained. The entire column including the salt cylinders and dye pellets are then inserted into the cavity drilled in the Baratol 12. The height of the dye pellets in the salt cylinder-dye column will be as shown in FIG. 1, to enable accommodation of a salt wafer 20, having a thickness equal to the wall thickness of salt cylinder 18, the wafer 20 protecting the dye column from the high temperature caused upon explosion of booster pellet 22, suitably made of tetryl or RDX (cyclonite). The wafer 20 is manufactured similarly to salt cylinder 18.

Booster pellet 22 propagates the explosive train from the fuze F to the Baratol, the booster pellet being in-

serted atop salt wafer 20 of the Baratol cavity.

The Felt washer 24, having an outer diameter substantially identical with the booster pellet, is placed atop the booster pellet and functions to take up any slack of the materials in the Baratol cavity. The hole in washer 24 insures propagation of the explosive train from the fuze directly into the booster pellet.

A closing plug 26 is threadedly mounted within a front portion of shell 10 and is moisture-sealed thereto by any suitable moisture sealing compound. The projectile P, or warhead, containing fuze F, is attached to the shell by means well known.

In FIG. 2, the salt cylinder-dye column of FIG. 1 is replaced by the salt-dye pellet 30. The outer diameter of pellets 30 will be substantially identical to that of salt cylinders 18. A salt wafer 20 is placed atop salt-dye pellets 30 and the tetryl or RDX booster 22, felt washer

24, and plug 26, is assembled as described above.

Data for out salt-dye pellets are presented in Table II below:

TABLE II.—SALT-DYE PELLET DATA

Smoke marker, color	Composition	Weight percent	Complying with MIL spec	MIL spec, dated
Red	1-methylaminoanthraquinone	75±1	PA-PD-382 (Rev. 1) (Pending review of MIL-D-3284)	14 December 1955.
	Rock salt	20±1	MIL-S-2072	28 February 1950.
	Stearic acid	5±1	MIL-S-271B	25 May 1962.
Yellow	Dye, vat yellow 4	56±1	MIL-D-50020B	15 July 1963.
	Benanthrone	19±1	MIL-D-50074B	1 July 1963.
	Rock salt	20±1	MIL-S-2072	28 February 1950.
	Stearic acid	5±1	MIL-S-271B	25 May 1962.
Blue	1,4-dimethylaminoanthraquinone	75±1	PA-PD-313	31 July 1953.
	Rock salt	20±1	MIL-S-2072	28 February 1950.
	Stearic acid	5±1	MIL-S-271B	25 May 1962.
Green	1,4-dimethylaminoanthraquinone	33±1	PA-PD-313	31 July 1953.
	Dye, vat yellow 4	31.5±1	MIL-D-50020B	15 July 1963.
	Benanthrone	10.5±1	MIL-D-50074B	1 July 1963.
	Rock salt	20±1	MIL-S-2072	28 February 1950.
	Stearic acid	5±1	MIL-S-271B	25 May 1962.

The salt-dye pellets are conveniently made by dissolving the required amount of salt in sufficient water to produce a super-saturated salt water solution which is then blended with the specific dye and stearic acid to form a mix. A commercial wetting agent may be added as required to facilitate blending. The mix is blended in a suitable mixer until a sufficient amount of water is driven off to produce an extrudable mix. The material is then extruded through a perforated dye to form spaghetti-type strands which lend themselves readily to rapid drying and to increase the bulk density of the material. The salt-dye blend will be dried to a moisture content of about 1 to 2 per cent and granulated to a particle size which assures free flow in the hopper and dye of the pelleting press. The salt-dye blend may now be pelleted to a density of about 1.25 to 1.35 gm/cm³.

We have discovered that the above procedure provides uniform distribution of the fine salt particles in the dye. Further, the salt particles act as a heat sink on a particle size level rather than in a pellet size as shown in FIG. 1. Additionally, the small mass of the individual salt particles aid in their wide spread dispersion into the atmosphere and the great number of these salt particles dispersed provides more nuclei for the sublimated dye to condense upon to yield a denser, more vividly colored cloud.

In the embodiment of FIG. 1 or modification of FIG. 2, upon firing of the cartridge, mortar or rocket motor, a fuze of the warhead or shell will arm in flight. On impact with a target area, the fuze initiates, firing the booster pellet 22 which initiates the Baratol 12, exploding shell 10 outwardly to produce lethal fragments. The salt absorbs the portion of heat of explosion of the Baratol, the salt being dispersed, along with the sublimated dye, into the atmosphere. Upon reaching the surrounding atmosphere, the dye cools and condenses on the salt particles producing a visible salt cloud of desired color at the impact area, the cloud persisting for extended periods.

We claim:

1. In an implosive pyrotechnic device capable of traveling through the atmosphere to a designated target area, said device including a shell and a projectile having an armable fuze associated therewith, the combination therewith of

an explosive having an axial cavity therethrough disposed centrally longitudinally within said shell and

means contained within said cavity for covering an area with a colored smoke cloud upon bursting of said shell comprising:

- A. A compressed rock salt cylinder having a bore therethrough, and
- B. Organic dyestuff disposed within said bore of said salt cylinder.

2. The device as described in claim 1 wherein said means comprises

- a. a compressed rock salt cylinder having a bore therethrough, said cylinder consisting essentially of 96.5 to 98.5 weight per cent rock salt and 1.5 to 3.5 weight per cent stearic acid, said rock salt having a particle size ranging between about 30 to 60 microns, and
- b. dye pellets disposed within said bore of said salt cylinder.

3. The device as described in claim 1 wherein said means comprises a homogeneous mass of rock salt and dye.

4. The device as described in claim 1, further characterized by a booster disposed between said fuze and dye pellets, said booster being made of a material selected from the group consisting of tetryl and cyclonite,

a salt wafer disposed between said booster and said dye pellets, said salt wafer being identical in composition to said rock salt cylinder.

5. The device as described in claim 3, further characterized by a booster disposed between said fuze and said homogeneous mass of rock salt and dye, said booster being made of a material selected from the group consisting of tetryl and sefronite, a salt wafer disposed between said booster and said homogeneous mass, said salt wafer consisting of 96.5 to 98.5 weight per cent rock salt and 1.5 to 3.5 weight per cent stearic acid, said rock salt having a particle size ranging between about 30 to 60 microns.

6. The device as described in claim 4, wherein said dye pellets comprise about 94 to 96 weight per cent 1-methylaminoanthraquinone, and about 4 to 6 weight percent stearic acid, said dye pellets producing a red smoke upon ignition of said explosive.

7. The device as described in claim 4 wherein said dye pellets comprise about 73 to 77 weight percent of a vat yellow 4 dye, about 18 to 22 weight percent of

benzanthrone, and about 4 to 6 weight percent stearic acid, said dye pellets producing a yellow smoke upon ignition of said explosive.

8. The device as described in claim 4, wherein said dye pellets comprise about 94 to 96 weight per cent 1,4-dimethylaminoanthraquinone, and 4 to 6 weight percent stearic acid, said dipellets producing a blue smoke upon ignition of said explosive.

9. The device as described in claim 4 wherein said dye pellets comprise about 41 to 43 weight percent 1,4-dimethylaminoanthraquinone, 39 to 41 weight percent vat yellow 4 dye, 12 to 14 weight percent benzanthrone, and 4 to 6 weight percent stearic acid, said dye pellets producing a green smoke upon igntion of said explosive.

10. The device as described in claim 5 wherein said mass comprises about 74 to 76 weight percent 1-methylaminoanthraquinone, 19 to 21 weight per cent rock salt, 4 to 6 weight percent stearic acid, said mass producing a red smoke upon ignition of said explosive.

11. The device as described in claim 5 wherein said mass comprises about 55 to 57 weight percent of vat yellow 4 dye, about 18 to 20 weight percent benzanthrone, about 19 to 21 weight percent rock salt, and 4 to 6 weight percent stearic acid, said mass producing a yellow smoke upon ignition of said explosive.

12. The device as described in claim 5 wherein said mass comprises about 74 to 76 weight percent 1,4-dimethylaminoanthraquinone, about 19 to 21 weight percent rock salt, and 4 to 6 weight percent stearic acid, said mass producing a blue smoke upon ignition of said explosive.

13. The device as described in claim 5 wherein said mass comprises about 32 to 34 weight percent, 1,4-dimethylaminoanthraquinone, about 30.5 to 32.5 weight per cent vat yellow 4 dye, 9.5 to 11.5 weight percent benzanthrone, 19 to 21 weight percent rock salt, and 4 to 6 weight percent stearic acid, said mass producing a green smoke upon ignition of said explosive.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,717,097 Dated February 20, 1973

Inventor(s) ADOLPH A. WRONKA, ET. AL.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet [73], "Navy" should read -- Army -- .

Signed and sealed this 20th day of November 1973.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

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