United States Patent [19]

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[11] **3,762,147**

[45] **Oct. 2, 1973**

[54] **APPARATUS OF RELAXING DRAWN HIGH-POLYMERIC FILAMENT THREADS**

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[22] Filed: **July 15, 1971**

[21] Appl. No.: **162,962**

Related U.S. Application Data

[60] Division of Ser. No. 858,188, Sept. 15, 1969, which is a continuation of Ser. No. 580,002, Sept. 16, 1966.

[52] **U.S. Cl.** **57/55.5**, 425/445, 425/363, 28/62, 28/71.3

[51] **Int. Cl** **D02j 1/22**, D01d 5/20, B29d/7/24

[58] **Field of Search** ..... 18/1 FT, 1 FZ, 1 FS; 57/55.5; 425/445, 363; 28/62, 71.3

[56] **References Cited**

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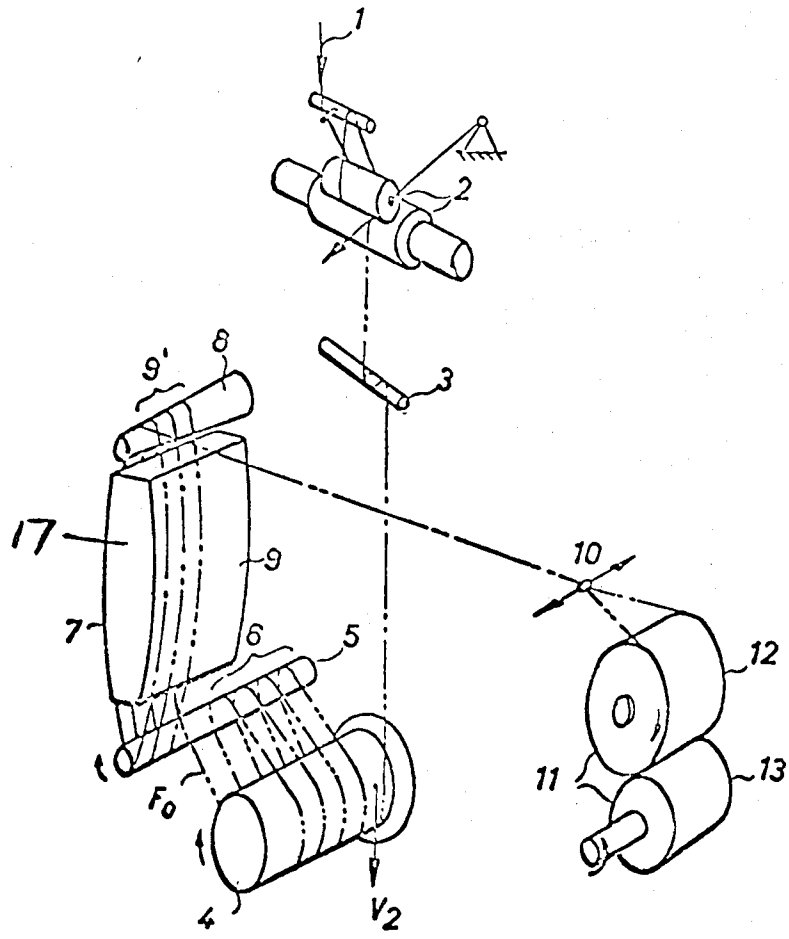
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[57] **ABSTRACT**

The high-polymeric filament thread is relaxed by being passed over the convexed sides of the heating element as well as over an upper stationary roll and a lower rotating roll. Each winding of the thread in this relaxing zone is heated so as to cause relaxation without allowing any substantial cooling down of the thread. The thread tension is reduced about the rotating roll so as to maintain the thread tension below the tension caused by relaxation of the thread. The thread is delivered from the relaxing zone at a tension slightly higher than the initial tension as supplied to the relaxing zone.

8 Claims, 3 Drawing Figures



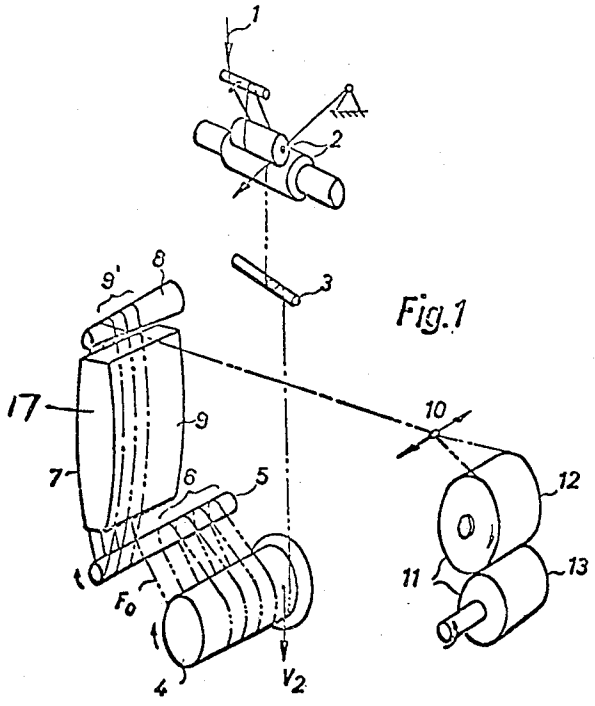


Fig.1

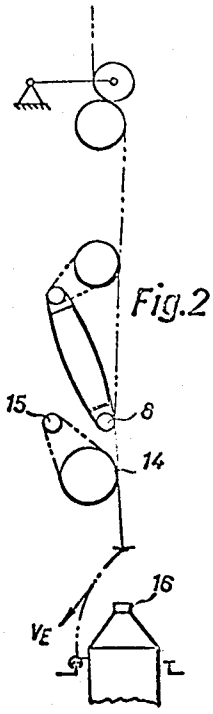


Fig.2

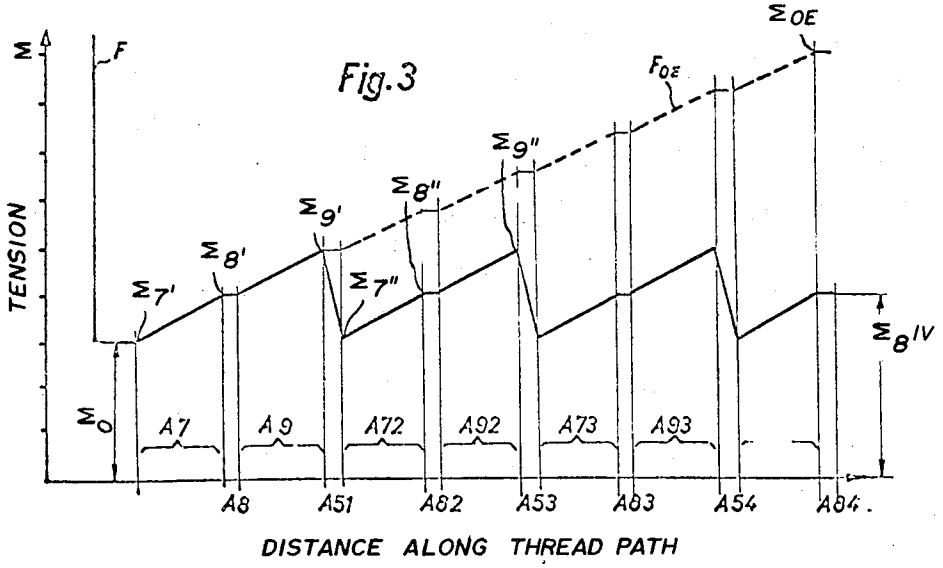


Fig.3

APPARATUS OF RELAXING DRAWN HIGH-POLYMERIC FILAMENT THREADS

RELATED U.S. APPLICATIONS

This is a division of application Ser. No. 858,188 now abandoned filed Sept. 15, 1969 which, in turn, is a continuation of Ser. No. 580,002 now abandoned filed Sept. 16, 1966.

This invention relates to an apparatus and method of relaxing drawn high-polymeric filament threads. More particularly, this invention relates to an apparatus and method of relaxing drawn high-polymeric mono-or multi-filament threads subsequent to a drawing of the filaments to a multiple of the initial length.

Heretofore, various methods have been known to relax endless high-polymeric threads after the threads have been drawn in a drawing zone. In some instances, the threads have been laid in several windings around a drawing roller and a smaller deflecting roller and directed onto and around a separated stationary or rotatable heating roller of smaller diameter in several windings in order to effect relaxation of the drawn thread. Where the heating roller has been rotatable the thread has been used to drive the heating roller. The thread has then been transferred to the drawing roller or deflecting roller and from there to a winding station. In order to increase the length of contact with the heating roller as much as possible, the thread has been guided crosswise in the path of travel to the heating roller. However, this has been disadvantageous. First, if the heating roller is stationary, the thread has been looped at a high angle at crossed thread run thereby causing a great deal of friction which has not only impaired relaxation but also winding due to the high thread tension produced. Second, if the heating roller is rotated in order to reduce tension, the maintenance of the necessary heating temperature on the rotating roller has been difficult, as is well known. Further, an undesired cooling of the thread has occurred in the windings during travel to and away from the heating roller contact surfaces. Also, because the thread has contacted the heating roller over a short distance, the time available for action of the temperature to effect a crystalline transformation has been extraordinarily short.

In order to overcome these above disadvantges methods of relaxing high-polymeric multi-filament threads have been proposed wherein the thread is laid several times over a heated godet roll and over a small deflecting roller associated therewith and wherein a slightly convex contact heating element, effective on both sides, is mounted between the deflecting roller and the godet roll so that the thread is lain on the heating element during travel from the godet roll to the guide roller and conversely. The rotating godet roll which has been of relatively great diameter has been heated by necessity in order to prevent repeated, considerable and undesired cooling of the thread while on the godet roll. However, accurate maintaining of the required temperature of the heated, revolving godet roll has presented a problem which is difficult to solve. In addition, this method has the disadvantage that the looping angle on the godet roll is substantially above 180° because of the geometrical conditions. Thus, at the necessary slippage called for by the relaxation, relatively great thread tensions have originated at the godet roll in counteraction to the relaxing forces so as to impair

the rearrangement of the molecules accompanying the relaxation.

A further shortcoming of this method has been the piling up of the thread material at unnoticed windings of the godet roll causing jamming between the godet roll and the adjacent heating element. However, the use of step-godet rolls has partly overcome this shortcoming.

Generally, the invention provides an apparatus and method of relaxing drawn high-polymeric filament threads which overcomes the above disadvantages and problems.

The invention provides a thread relaxing apparatus for use with a drafting assembly having a drafting roller rotatable at a first peripheral speed for drawing a high-polymeric filament thread to several times the initial length. The apparatus includes a pair of spaced deflecting rollers and a convexly shaped heating surface means between the deflecting rollers around which a drawn thread is wound in a plurality of windings. One of the deflecting rollers is spaced from the drafting roller of the drafting assembly for receiving successive windings of the drawn thread from the drafting roller in order to reduce the thread tension substantially below the initial tension in the thread after drafting. In addition, this deflecting roller is positively rotatable at the same peripheral speed as the drafting roller for accelerating the thread about the heating surface means and the other deflecting roller. The heating surface means has a pair of oppositely disposed convex heating surfaces for slidably contacting the thread windings passing between the deflecting rollers so as to relax the windings of thread. The other of the deflecting rollers is freely rotatable in order to permit a reduction in the tension of the thread windings due to the relaxation of the thread under heating.

The deflecting rollers are sized relative to the heating surface means so that each is of a diameter less than the width or spacing between the heating surface ends thereby allowing the looping angle of the thread about each roller to be less than 180°. This allows for a reduction in the friction between the thread and rollers.

The invention further provides a means for receiving the relaxed thread from the relaxing apparatus to twist and wind the thread onto a suitable spool.

The method encompassed by the invention supplys a drawn thread at an initial tension from a drafting assembly to a relaxing zone containing the relaxing apparatus. Next, the thread is moved through the relaxing zone in a plurality of successive windings while each of the thread windings is heated to relax the thread. At the same time, the thread tension in each of the windings is reduced after heating for maintaining the thread tension below the tension caused by relaxation of the thread and for delivering the thread from the relaxing zone at a tension slightly higher than the initially supplied tension. Subsequently, the relaxed thread is wound at a reduced tension at a speed corresponding to the degree of relaxation.

Accordingly, it is an object of the invention to relax a drawn high-polymeric filament thread of one or more filaments at a reduced thread tension.

It is another object of the invention to reduce the friction due to sliding of a drawn high-polymeric filament thread on the surfaces of a thread relaxing apparatus.

It is another object of the invention to relax a drawn high-polymeric filament thread without braking of the thread.

It is another object of the invention to relax a drawn high-polymeric filament thread in a manner to permit a direct winding of the relaxed thread at a desired low thread tension.

It is another object of the invention to draw a drawn high-polymeric filament thread into a relaxing zone at a slightly greater initial tension without substantially increasing the final tension of the thread leaving the relaxing zone.

It is another object of the present invention to provide an apparatus wherein a deflecting roller rotating at a circumferential speed greater than the traveling speed of the thread running on the deflecting roller for accelerating the thread, also serves as a positively driven roller for a relaxing zone which comprises a freely rotating second roller spaced from said driven roller, and slightly convex heated contact surfaces which are placed between the rollers and in contact with the thread.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a schematic perspective view of a general arrangement of the thread path and of the heating element according to the invention;

FIG. 2 illustrates a schematic view of a modified thread path; and

FIG. 3 illustrates a graph wherein the thread tension is plotted over the relaxing zone.

Referring to FIG. 1, a high-polymeric, undrafted thread 1 consistig of an endless filament bundle or of a monofilament is supplied to a pair of feed rollers 2 rotating at a circumferential speed V_1. The thread 1 travels from the feed rollers 2 around a drafting pin 3 to a drafting roller or godet roll 4 which rotates at a circumferential speed V_2 several times the circumferential speed V_1 so that, as is well known, the thread 1 is stretched in this zone to a multiple of its initial length. The thread travels in several windings 6 from the godet roll 4 to a deflecting roller 5 and therefrom again to the godet roll 4. After completing the windings 6, the thread leaves the roller 5 which rotates at the peripheral speed V_2 under the driving force of the windings 6 in an upward direction and touches the left side 7 of a convexly shaped contact heating element 17. Thereafter the thread travels onto a conical freely rotating auxiliary roller 8 which delivers the thread to a convex contact heating surface 9 at the right side of the heating element 17. The thread is then received by the roller 5 and deflected again in an upward direction toward the heating surface 7. After forming several windings 9' over the two heating surfaces 7 and 9, whereby the thread is sufficiently heated, the thread contracts, i.e. relaxes to the desired extent. Thereafter, the thread leaves the deflecting roller 8 at the small diameter end and travels by way of a transverse motion device 10 to a winding arrangement 11 formed by a bobbin 12 and a friction roller 13 which drives the bobbin 12.

The heating surfaces 7 and 9 are of slight convex shape to cause only a slight increase in the tension of the thread sliding thereover so that the friction forces are held low. Also, the diameters of the two deflecting rollers 5 and 8 are small in order to reduce the path to be traveled by the thread between the two heating surfaces and are preferably smaller than the distance between the ends of the heating surfaces adjacent thereto. Thus, the looping angle of the thread around the roller 5 as well as around the auxiliary deflecting roller 8 is smaller than 180° to further reduce the friction forces. Although a greater friction would be desirable between the threads and the deflecting roller 5 which serves as a drive roller for the thread traveling over the heating surfaces 7 and 9, an increase of the diameter of the roller 5 is opposed to the more important demand of the lowest possible cooling of the thread. However, the friction produced on the roller 5 is quite sufficient to reduce the thread tension to the desired degree, as is discussed later in regard to the diagram of FIG. 3.

This apparatus allows the thread tension to be successively reduced during relaxing of the thread in the windings 9' and held low during the pulling-off of the thread by the winding arrangement 11.

Referring to FIG. 3, the method utilized by the above apparatus, for example, for a multifilament thread F_0 having a total titer of about 70 and consisting of individual polyamide threads (Nylon 66) of three deniers, delivers the thread to the drafting godet roll 4 at a speed V_2 of 1,200 meter per minute and to the roller 5 at a stretch tension of about $\Sigma_0 = 6g$ after a reduction of the stretch tension from $\Sigma = 300g$ in the windings 6.

The thread tension Σ_0 is held as low as possible in order to obtain a low delivery value but must not be below a minimum value, for example, 6g, because otherwise, the tension does not suffice to correctly draw the thread from the godet roll 4 and there would be danger of lap formation. After reaching the heating surface 7 which is about 150mm long and heated to 155°C at a threat tension $\Sigma_{7'} = \Sigma_0$, the thread moving at a speed $V_2 = 1{,}200$ meter per minute is subjected to a first tension increase to $\Sigma_{8'}$ in the abscissa zone A7 of FIG. 3 due to the friction of the surface 7. The thread tension is maintained during the deflection by the roller 8 (zone A8 in FIG. 3). Next, the thread runs on the heating surface 9 which is also 150mm long and heated to 150°C and the thread tension is increased to $\Sigma_{9'}$ (zone A9). Thereafter, the thread reaches the driven roller 5 for the first time whereon the thread tension is reduced to $\Sigma_{7'}$ (zone A51). Subsequently, the process is repeated so that the tension is again increased to $\Sigma_{8'}$ (zone A72) due to friction on the heating surface 7. After a brief period in the zone A82 (deflecting roller 8) the thread tension increases to $\Sigma_{9'}$ in zone A92 (heating surface 9). After passing through the zones A53, A73, A83, A93, A74 and A84 corresponding to the elements 5, 7, 8, 9, 5, 7 and 8, the thread runs on the transverse motion device 10 and the winding device 11 at a tension Σ_8IV. This tension is only 2g, i.e. about one-third higher than the very low initial tension Σ_0. The total relaxation amounts to about 12 percent.

To afford comparison, the thread tensions which must be expected if the thread tension is not reduced several times by driving the deflecting roller 5 and the thread thereon is plotted as a dotted line in FIG. 3. In this case, the final tension $\Sigma_0 E$ is about three times the initial tension Σ_0.

The aforedescribed mode of operation permits repeated passage over the friction producing heating surfaces and a longer dwell in the heating zone of the thread which enables reduction of the heating temperature. This is important because evaporation of certain

oil components of a preparation applied to the thread is prevented. The overall efficiency of the heating operation is thus considerably improved.

Referring to FIG. 2, instead of traveling directly on the winding arrangement from an auxiliary deflecting roller 8', the thread passes over a second godet roll 14 and a deflecting roller 15 acting as a delivery roller. The thread runs from the deflecting roller 15 onto a ring twisting spindle 16 which twists the thread around its longitudinal axis while winding the thread. The spindle 16 requires a positive supply of thread at a certain velocity V_E which is assured by controlling the delivery speed of the thread from the relaxing arrangement by means of the godet roll deflecting roller unit 14, 15 arranged downstream of the deflecting roller 8'.

The invention provides for a reduction in thread tension after each winding to such a degree that the tension in the thread caused by the relaxing forces is not exceeded and that the thread leaves the relaxing zone at a tension which is negligibly greater than the initial tension so as to be wound at the reduced tension. A further characteristic of the invention is the reduction of the thread tension after each winding by means of a deflecting roller whose circumferential speed exceeds the traveling speed of the thread at this location. Further, because the thread is laid so many times around the deflecting rollers and the heating surfaces placed therebetween, the time necessary for satisfactory relaxation is assured without undue increase of thread tension.

It is noted that the slightly curved, convex heating surfaces produce small friction forces on the threads which greatly facilitate relaxation. Also, since all the looping angles around the deflecting rollers are smaller than 180°, a further reduction of friction is made because relaxing is impossible without slippage on the rollers. The running-off tension of the thread is considerably reduced because the first deflecting roller rotates at the delivery velocity of the drawing zone to that the thread is driven after each passage over the heating surfaces. In contradistinction to conventional arrangements there is no braking of the thread which opposes relaxation. There is, instead, an acceleration of the thread which reduces thread tension.

Working with reduced thread tension has further direct consequences. First, drawing into the relaxing zone can be done at a somewhat greater initial tension without substantially increasing the final tension. This is important because too much reduction of the drawing-in tension results in licking of the respective rollers and in an irregular thread run. Second, with the arrangement according to the invention, thread delivery is obtained at reduced end tension which makes possible a direct winding at a desired low thread tension.

It is noted that with respect to the multifilament thread exemplified above for a total titer (or denier) of 70, the initial tension of 6 grams for the thread imposes an initial tension on the filaments of 0.085 grams/denier and the final tension upon leaving the relaxing zone for the winding device imposes a tension of 0.115 grams/denier.

Having thus described the invention, it is not intended that it be so limited as changes may be readily made therein without departing from the scope of the invention. Accordingly, it is intended that the subject matter described above and shown in the drawings be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In combination with a drafting assembly having a drafting roller rotatable at a first peripheral speed for drawing high-polymeric filament threads to several times the initial length; an apparatus downstream of said drafting roller for relaxing the drawn threads comprising a first rotatable deflecting roller spaced from said drafting roller for successive winding of the drawn thread around said drafting roller and said deflecting roller to reduce the thread tension, said first deflecting roller being positively rotatable at said first peripheral speed for accelerating the thread, a second freely rotatable deflecting roller spaced from said first deflecting roll for successive winding of the reduced tension thread therebetween to allow acceleration of successive windings of the thread to reduce the thread tension, and a convexly shaped heating surface means disposed between said first and second deflecting rollers for slidably contacting the thread passing between said deflecting rollers to relax the thread.

2. The combination as set forth in claim 1 wherein said heating surface means includes a pair of oppositely disposed convex heating surfaces, said heating surfaces being spaced apart at the respective ends thereof a distance greater than the diameter of said deflecting rollers at said respective ends whereby the thread loops around each said deflecting roller on a looping angle less than 180°.

3. The combination as set forth in claim 1 wherein said second deflecting roller has a tapered configuration.

4. The combination as set forth in claim 1 wherein said second deflecting roller is stepwisely reduced from one end to the other end.

5. The combination as set forth in claim 1 which further comprises means for receiving the relaxed thread from said second deflecting roller, said means including means for twisting and winding the received thread.

6. The combination as set forth in claim 5 wherein said receiving means includes a positively driven delivery roller for receiving the relaxed thread and for directing the received thread to said means for twisting and winding the thread.

7. In combination with a drafting assembly having a drafting roller rotatable at a first peripheral speed for drawing high-polymeric filament threads to several times the initial length; an apparatus for relaxing the drawn threads comprising a first rotatable deflecting roller spaced from said drafting roller for successive winding of the drawn thread around said drafting roller and said deflecting roller to reduce the thread tension, said first deflecting roller being positively rotatable at said first peripheral speed for accelerating the thread, a second freely rotatable deflecting roller of tapered configuration spaced from said first deflecting roller for successive winding of the reduced tension thread therebetween to reduce the thread tension, and a convexly shaped heating surface means disposed between said first and second deflecting rollers for slidably contacting the thread passing between said deflecting rollers to relax the thread.

8. In combination with a drafting assembly having a drafting roller rotatable at a first peripheral speed for drawing high-polymeric filament threads to several times the initial length; an apparatus for relaxing the drawn threads comprising a first rotatable deflecting roller spaced from said drafting roller for successive winding of the drawn thread around said drafting roller

and said deflecting roller to reduce the thread tension, said first deflecting roller being positively rotatable at said first peripheral speed for accelerating the thread, a second freely rotatable deflecting roller spaced from said first deflecting roller for successive winding of the reduced tension thread therebetween to reduce the thread tension, said second deflecting roller being stepwisedly reduced from one end to the other end and a convexly shaped heating surface means disposed between said first and second deflecting rollers for slidably contacting the thread passing between said deflecting rollers to relax the thread.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,762,147 Dated October 2, 1973

Inventor(s) Olivier Wuest

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

Column 4, line 44, delete "24".

Column 4, line 47, delete "4" .

Signed and sealed this 26th day of March 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.