

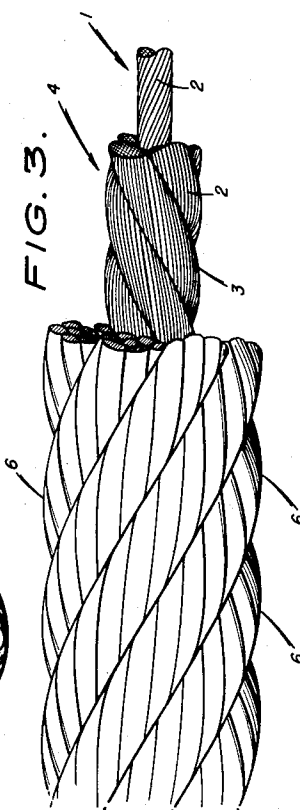
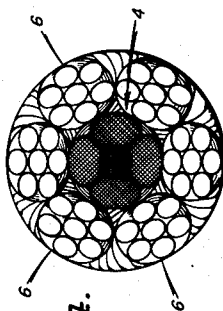
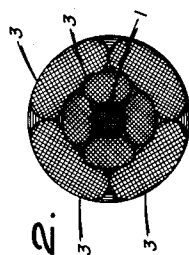
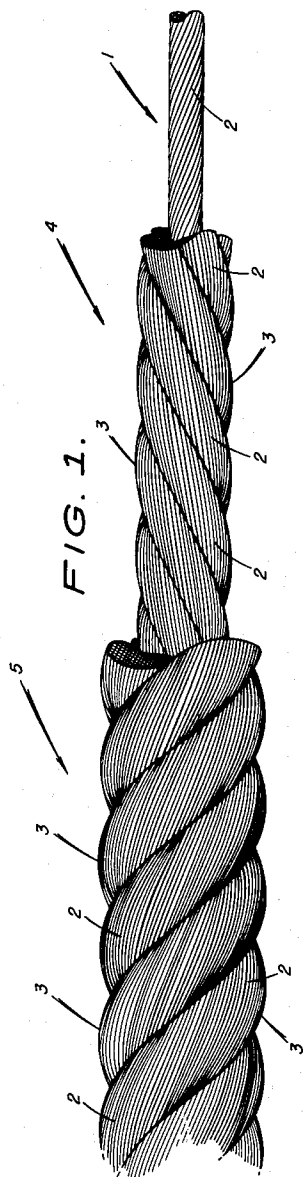
Aug. 3, 1965

H. D. DAWBARN ETAL

3,197,953

POLYPROPYLENE ROPE

Filed June 3, 1963



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3,197,953

## POLYPROPYLENE ROPE

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Filed June 3, 1963, Ser. No. 284,912

8 Claims. (Cl. 57-147)

The present invention relates to a novel and useful product, a process for stabilizing the product and to a final structure utilizing the product. More particularly, it relates to a polypropylene rope, a process for stabilizing the rope and a cable containing the rope as a core.

In the formation of cable, such as steel cables, the natural fiber sisal is generally employed as the core as it is relatively inexpensive, resilient and processes quite well. Cable fabricated with sisal cores, however, suffer from the disadvantage that the cores are subject to attack by microorganisms, fungus, acid conditions, moisture and the like. In addition, the sisal core has quite low abrasion resistance. Quite obviously, if a suitable core could be produced which did not have the aforementioned disadvantages, it would receive widespread acceptance in the cable field.

It is an object of the present invention to provide a novel and useful polypropylene rope which is particularly suited for use as the core in conventional cables. A further object is to provide a process for stabilizing the polypropylene rope. A still further object is to provide a steel cable which is not subject to attack by fungus and other microorganisms. Another object is to provide a cable core which has increased resistance to moisture and acid conditions. Other objects will become apparent as the description of the invention proceeds.

These objects are accomplished by the present invention which provides a polypropylene rope containing: (A) a central heart strand and (B), around the heart strand, at least one wrap having at least 3 strands in side by side relationship with the direction of adjacent wraps being opposite to each other and with the twist of the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000. In a preferred embodiment of the present invention, the direction of the first wrap is the same as that of the heart strand and the rope contains from 1 to 5 wraps each having from 3 to 7 strands/wrap.

The present invention also provides a process for stabilizing a polypropylene rope which comprises heating the rope to a temperature of from about 135° F. to about 300° F. and stretching the rope from about 5 to about 50% while the rope is in a heated state. In the preferred embodiment of the present invention, the stabilization process is carried out at a temperature from about 170° F. to about 225° F. and the rope is given a stretch from about 10% to about 40%. In a still more preferred embodiment, the temperature is from about 190° F. to about 212° F. and the rope is stretched from about 15% to about 25%.

In addition, the present invention provides a cable containing: (A) a central heart strand, (B) and around the heart strand, at least one wrap having at least 3 strands in side by side relationship with the direction of adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands, each of said strands having a twist of from about 2 to

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about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to 1,000 and (C) an outer wrap containing a plurality of metal strands in side by side relationship with each metal strand containing a plurality of continuous metal filaments.

It is essential in order to have a complete understanding of the present invention that the direction of twist and direction of wrap be fully understood. Whenever a plurality of filaments are twisted about each other, the resulting multifilament strand when viewed longitudinally will show filaments running from upper left to lower right (\) or, in the alternative, from upper right to lower left (/). It is conventional in the textile field to refer to a multifilament strand as having an S twist when such filaments run from upper left to lower right since the filaments run in the same direction as the middle portion of the letter S (\). When the direction is reversed, the filaments run in the direction of the middle portion of the letter Z (/) and are referred to as having a Z twist. In a similar fashion, when multifilament strands are plied together, they result in either a Z or S direction. Thus, in the present invention, the individual twisted strands have a Z or S direction and when such strands are plied into a wrap, the wrap itself has a Z or S direction.

The term "filament" merely signifies a unitary structure which has two dimensions which are very small as compared to the third dimension (length). It is synonymous with the term monofilament as employed in the textile field. The terms "oriented" and "continuous" are used as in the textile field to mean a structure which has been stretched to "orient" or axially align the molecules and in which, in addition, represents a substantially uniform continuous mass of material from one end of the rope to the other end. The degree of orientation, of course, will depend upon the amount of stretch imparted to the filament prior to rope fabrication and it will, in general, be stretched from 3× to 12× its normal length. Preferably the material is stretched from 6× to 9× its normal length.

Each "strand" contains a plurality of such "filaments" which are twisted about their axis to give an S or Z "direction" to the "twist" of the strand. A plurality of strands are then wrapped in abutting or "side by side" relationship to form a "wrap" which also has an S or Z "direction." The first wrap, which is the innermost wrap, is formed by employing a plurality of strands and wrapping them around a center strand which is commonly referred to in the art as a "central heart strand." The term "rope" merely signifies a product which is formed by plying together the filaments, strands and wraps as described above.

The term "polypropylene" is used in its conventional sense to mean the polypropylene homopolymer or a polypropylene copolymer containing minor amounts (i.e., about 3% or less) of one or more alpha-olefin comonomers (see U.S. Patents 2,911,384, 3,006,829, 3,062,801, 3,078,250 and others). The "plastic composition" containing the polypropylene may, of course, contain optional ingredients such as pigments, delustrants, plasticizers, flame retardant materials, antistatic agents and other such materials as known in the art. It may even contain other plastics blended with the polypropylene.

The expression "stabilizing" merely means that the rope will not readily unwind, untwist and fray when cut. The terms "cable" and "metal" are conventionally used. In fabricating such cables, steel filaments (such as S.A.E. 1025-1095) will generally be employed, but other cables require various alloys and the polypropylene rope is equally suitable as a core in such cables. In general,

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the cables will be of the type employed in construction, elevators, oil well drilling equipment, pulleys and the like.

The invention is hereinafter more fully described by reference to the drawings.

In the accompanying drawings which illustrate a preferred embodiment of the present invention:

FIGURE 1 is a perspective view of a polypropylene rope produced in accordance with the present invention;

FIGURE 2 is an end view of the polypropylene rope shown in FIGURE 1;

FIGURE 3 is a perspective view of a cable utilizing a polypropylene rope as a core; and

FIGURE 4 is an end view of the cable shown in FIGURE 3.

In FIGURES 1 and 2, the second and outer wrap 5 contains four strands 3 which are wrapped Z about the first and inner wrap 4. Each of the strands 3 in the outer wrap 5, contains a plurality of filaments 2, which are S-twisted prior to the formation of the wrap. The first wrap 4 is opposite in direction to that of the outer adjacent wrap 5. The first wrap 4 is S in direction and contains four strands 3, each of which contains a plurality of filaments 2 with a Z twist. The heart strand 1 contains a plurality of filaments 2 which are Z-twisted. Thus, the outer or second wrap 5 is opposite in direction to the inner or first wrap 4 which in turn is opposite to that of the heart strand 1. In all instances, the adjacent wraps are opposite in direction, i.e., one is S-wrapped and one is Z-wrapped. In a preferred embodiment of the present invention, the first wrap 4 has the same direction as that of the heart strand 1, although in FIGURE 1 opposite directions are shown.

In FIGURES 3 and 4, the heart strand 1 contains a plurality of filaments 2 which are Z-twisted. The first and only wrap 4 contains four strands 3, each of which contains a plurality of filaments 2. The direction of the wrap is S and the twist of each strand is Z. The heart strand 1 and outer wrap 4 form a rope which is used as the center of a cable as shown in FIGURES 3 and 4. The rope contains an outer layer of steel strands 6 which are Z-wrapped about the rope although an S direction could also be used with the same rope.

The following examples are given to illustrate the invention and are not intended to limit it in any manner.

#### EXAMPLE 1

##### Procedure A

A commercial polypropylene homopolymer having a melt index of 1.0 is fed into a "Hartig" 2½" extruder having a length to diameter ratio of 24 to 1 and equipped with electrical temperature controls covering 3 heating zones. The temperature profile is Zone 1 (feed end)=360° F., Zone 2=480° F., Zone 3=580° F. and die temperature=580° F. The molten polymer is extruded through a die containing 76 circular orifices, 30 mils (0.030") in diameter to give 76 filaments which are drawn 8×. Each filament has an average denier of 460. The untwisted filaments are collected on a cardboard core package. The group of 76 filaments is twisted together on a commercial "Whirlwind" twister to give 20.5 turns/ft. Z twist to form a strand of 41,000 denier. A buildup of denier from the twist is noted.

##### Procedure B

A commercial rope twisting machine is employed to ply 4 of the 41,000 denier strands 10.5 turns/ft. (S-twist) about a fifth strand of the same size and twist to produce a rope containing a heart strand and 4 strands in the first and only wrap. The twisting machine in forming the first wrap removes one turn from each of the strands in the wrap for each turn put into laying them about the heart strand. The strands in the first wrap are in side by side relationship substantially as shown in the first wrap of FIGURE 1.

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##### Procedure C

The above core rope is run through a water tank containing 200° F. water at about 35 ft./min. to give a total immersion time of approximately 7 minutes. Just before leaving the tank, the rope passes over a series of pulleys. These consist of a stepped sheave on one shaft and a group of idling pulleys on the second. The rope goes over the first groove of the stepped pulley, around the idler pulley, and back around the second groove of the stepped pulley which is larger in diameter so as to stretch the rope by 5%. The rope passes over 4 steps to stretch it a total of 20%; 4 steps of 5% increase each. The final rope has an outside diameter of about ½" and is collected on a tube.

##### Procedure D

A ¼" steel cable is constructed as shown in FIGURE 4 employing the above rope as a central core. A conventional cable twisting machine is employed to wrap 6 steel (S.A.E. 1080) strands 2 turns/ft. (Z twist) around the core with each of the steel strands containing 7 steel filaments (each about ¼" in diameter)—6 of which are twisted (S twist) about the seventh at about 12 turns/ft. The construction is substantially as shown in FIGURES 3 and 4.

#### EXAMPLE 2

##### Procedure A

Procedure A of Example 1 is repeated employing the same polymer to give 45 filaments having an average denier of 600. The filaments are drawn 8× and are collected untwisted on a cardboard package. The group of 45 filaments is twisted together on a commercial "Whirlwind" twister to give 16.5 turns/ft. Z twist to form a strand of approximately 29,110 denier (some buildup of denier is noted due to the twist).

##### Procedure B

A commercial rope twisting machine is employed to ply 4 of the 29,110 denier strands 9.8 turns/ft. (S twist) about a fifth strand (of the same size and twist) to produce a rope containing a heart strand and 4 strands in the first wrap. The machine in forming the first wrap removes 1 turn from each of the strands in the wrap for each turn put into laying them about the heart strand. The strands in the first wrap are in side by side relationship substantially as shown in the first wrap of FIGURE 1.

The above product is now used as a core for twisting 4 more strands about it as a second wrap employing the same conventional rope twisting machine. Each of the 4 strands of the second wrap contains 76 filaments of 625 denier/filament which are twisted together 16.5 turns/ft. (S twist) giving a strand denier of about 56,120. The 4 strands are twisted about the first wrap 12.5 turns/ft. Z twist. The strands in both the first and second wrap are in side by side relationship substantially as shown in FIGURES 1 and 2.

##### Procedure C

Procedure C of Example 1 is repeated employing the above core rope containing a heart strand and a first and second wrap. The final rope has an average outside diameter of 1½" and is collected on a tube. The rope is suitable as a core rope for cables larger than the cable of Example 1.

#### EXAMPLE 3

Example 2 is repeated employing the following for the heart strand, first wrap and second wrap:

Heart strand—50 filaments (stretched 8×) of 600 denier, twisted Z, 20.5 turns/ft., to total of 31,150 denier.  
Strands for first wrap—60 filaments (stretched 8×) of 600 denier, twisted Z, 20.5 turns/ft., to total of 31,150 denier.

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First wrap—Four strands of above twisted about the above heart strand, 10 turns/ft., S twist.

Strands for second wrap—95 filaments (stretched 8×) of 600 denier, twisted S, 16.5 turns/ft., to total of 59,386 denier.

Second wrap—Above strands twisted about first wrap at 13.2 turns/ft., Z twist.

After running the resulting core rope through the water tank and stretching it a total of 20% as in Example 2, the final product has an outside diameter of about  $\frac{7}{16}$ " and is collected on a tube. It is suitable for use as a core rope for steel cables.

#### EXAMPLE 4

The procedure of Example 1 is completely repeated with the exception that in Procedure B the first wrap is Z-twisted about the heart strand (Z twist) employing 4 strands having an S twist. The turns/ft. and denier of all strands and filaments are the same.

The resulting rope appears to hold the heart strand tighter in place which aids in the formation of the final cable. The rope is stable, as in all the previous examples, and does not readily unwind or untwist when cut. In contrast, a rope which has not been subjected to the stabilization procedure, readily unwinds, untwists and frays when cut.

In order to determine the effective temperatures for stabilizing the polypropylene rope, a rope is produced in accordance with Procedure C of the same example employing water at different temperatures. The temperatures employed are at 5° intervals from 115° F. to 205° F. In this way, it is found that a temperature of about 135° F. is required in all cases. An exceptionally good product is obtained when the temperature is above 170° F. and preferably 190–212° F.

In a similar manner it is determined that a stretch of at least about 5% is required in order to stabilize the polypropylene rope. At about 50% stretch, the rope will contain some broken filaments if the filaments are highly oriented prior to the stabilization treatment. With polypropylene ropes containing less highly oriented filaments, a 50% stretch will produce a good product. Generally, a stretch of from about 10 to about 40% will be employed with oriented polypropylene filaments and a particularly preferred stretch is from about 15 to about 25%.

While in the above examples the heating medium employed is water, other fluids may be employed to accomplish the same results, provided appropriate temperatures are employed. Obviously, temperatures above the softening point of the polymer would not be suitable for the stabilization procedure.

The polypropylene rope of the present invention may be used as a core in the construction of conventional cables. The cables may be used wherever conventional cables are employed and are particularly suited for use in oil wells and the like wherein the cable is subject to the growth of microorganisms normally destructive to the natural sisal fiber of other cables.

Many other equivalent modifications will be apparent to those skilled in the art from a reading of the foregoing without a departure from the inventive concept.

What is claimed is:

1. A polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand and (B), around the heart strand, at least one wrap having at least 3 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other end with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 30

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turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000.

2. A polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand and (B), around the heart strand, at least one wrap having at least 3 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000; the said heart strand having a twist the same as that in the adjacent first wrap.

3. A polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand and (B), around the heart strand, from 1 to 5 wraps each having from 3 to 7 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000.

4. A polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand and (B), around the heart strand, from 1 to 5 wraps each having from 3 to 7 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 20 turns/ft., a total denier from about 25,000 to about 100,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 200 to about 800; the said heart strand having a twist the same as that in the adjacent first wrap.

5. A cable comprising, as a core, a polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand, (B) and around the heart strand, at least one wrap having at least 3 strands in one side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands, each of said strands having a twist of from about 2 to about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000; and, around the said polypropylene rope core, an outer wrap containing

a plurality of metal strands in side by side relationship with each metal strand containing a plurality of continuous metal filaments.

6. A cable comprising, as a core, a polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand, (B) and around the heart strand, at least one wrap having at least 3 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000; the said heart strand having a twist the same as that in the adjacent first wrap; and, around the said polypropylene rope core, an outer wrap containing a plurality of metal strands in side by side relationship with each metal strand containing a plurality of continuous metal filaments.

7. A cable comprising, as a core, a polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted heart strand, (B) and around the heart strand, from 1 to 5 wraps each having from 3 to 7 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands, each of said strands having a twist of from about 2 to about 30 turns/ft., a total denier from about 3,000 to about 250,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 3 to about 1,000; and, around the said polypropylene rope core, an outer wrap containing a plurality of metal strands in side by relationship with

each metal strand containing a plurality of continuous metal filaments.

8. A cable comprising, as a core, a polypropylene rope stabilized against unwinding, untwisting and fraying when cut by heating the said rope to a temperature of from about 135° F. to about 300° F. but below the softening point of the said polypropylene and stretching from about 5 to about 50 percent while in the heated state; said rope containing: (A) a twisted central heart strand, (B) and around the heart strand, from 1 to 5 wraps each having from 3 to 7 strands in side by side relationship with the direction of any adjacent wraps being opposite to each other and with the twist in the strands of any wrap being opposite in direction to that of the wrap itself which contains the strands; each of said strands having a twist of from about 2 to about 20 turns/ft., a total denier from about 25,000 to about 100,000 and containing a plurality of continuous oriented polypropylene filaments having an individual denier of from about 200 to about 800; the said heart strand having a twist the same as that in the adjacent first wrap; and, around the said polypropylene rope core, an outer wrap containing a plurality of continuous metal filaments.

#### References Cited by the Examiner

##### UNITED STATES PATENTS

|           |       |                   |        |
|-----------|-------|-------------------|--------|
| 271,548   | 1/83  | Trott et al.      |        |
| 1,492,977 | 5/24  | Gore et al.       | 57—144 |
| 1,757,156 | 5/30  | Wirkkala          | 57—147 |
| 2,055,037 | 9/36  | MacKinnon         | 57—144 |
| 2,343,892 | 3/44  | Dodge et al.      | 57—140 |
| 2,361,999 | 11/44 | Frey              | 57—157 |
| 2,591,628 | 4/52  | Snyder            | 57—140 |
| 3,016,682 | 1/62  | Gaston            | 57—140 |
| 3,018,610 | 1/62  | Kleinkathofer     | 57—157 |
| 3,026,669 | 3/62  | Stanton           | 57—140 |
| 3,048,963 | 8/62  | Himmelfard et al. | 57—140 |

##### FOREIGN PATENTS

|         |      |                |
|---------|------|----------------|
| 605,994 | 9/60 | Canada.        |
| 833,387 | 4/60 | Great Britain. |

MERVIN STEIN, *Primary Examiner.*