

June 30, 1942.

H. BUCHSBAUM ET AL

2,288,313

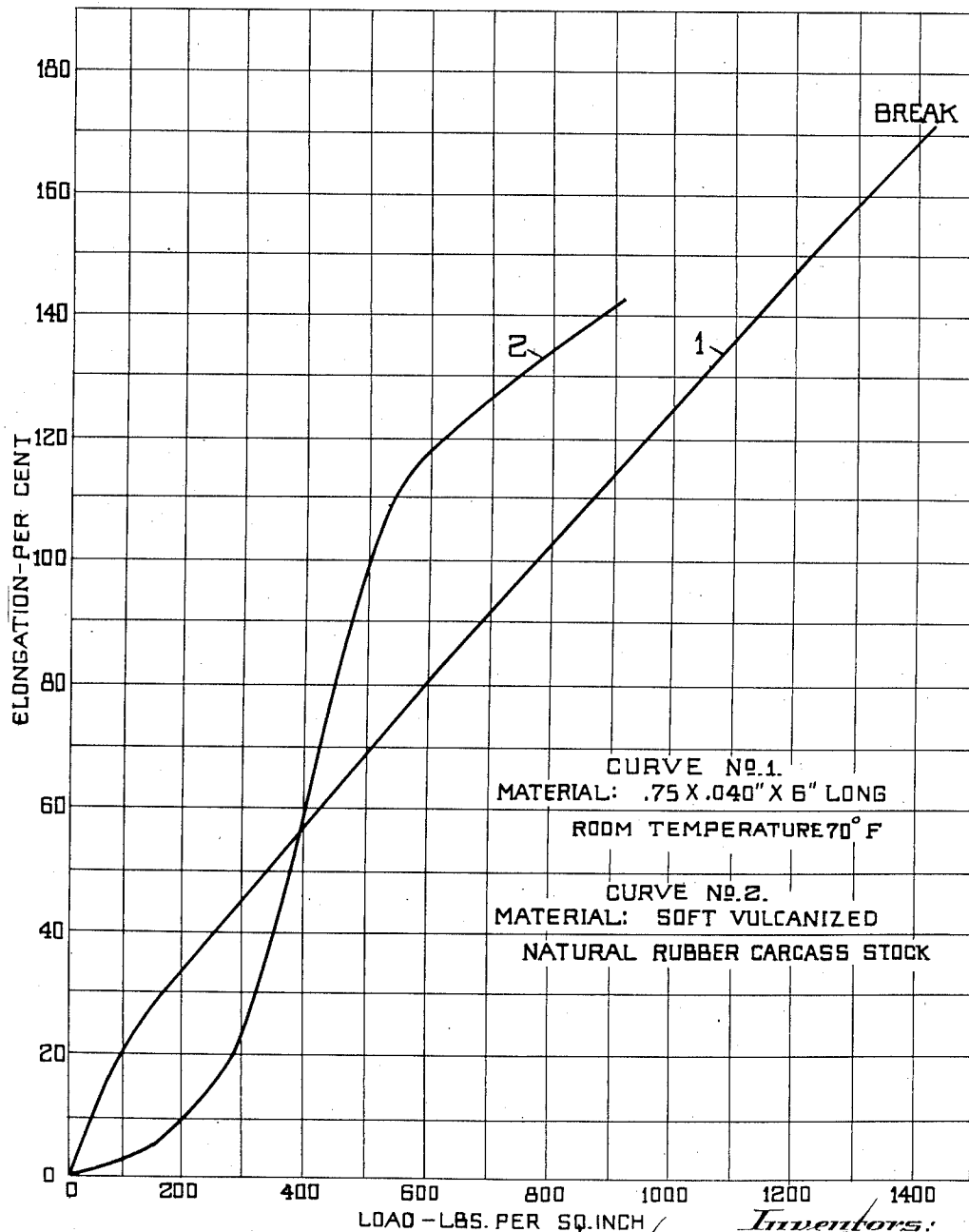
ARTICLES OF WEARING APPAREL, ACCESSORIES, AND THE LIKE

Filed Feb. 8, 1940

4 Sheets-Sheet 1

FIG.1.

STRESS-STRAIN GRAPH



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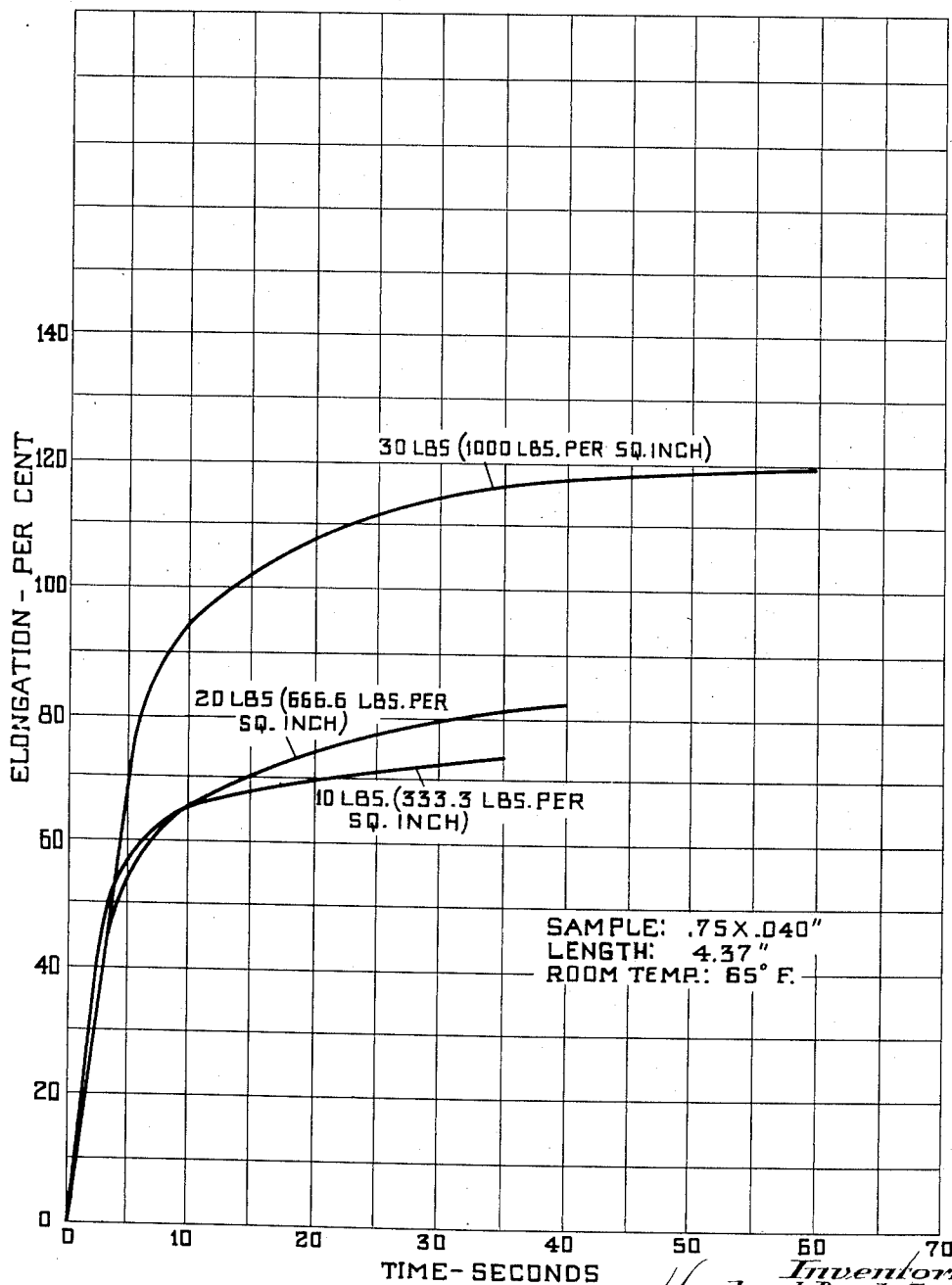
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FIG. 2.

ELONGATION-TIME TEST



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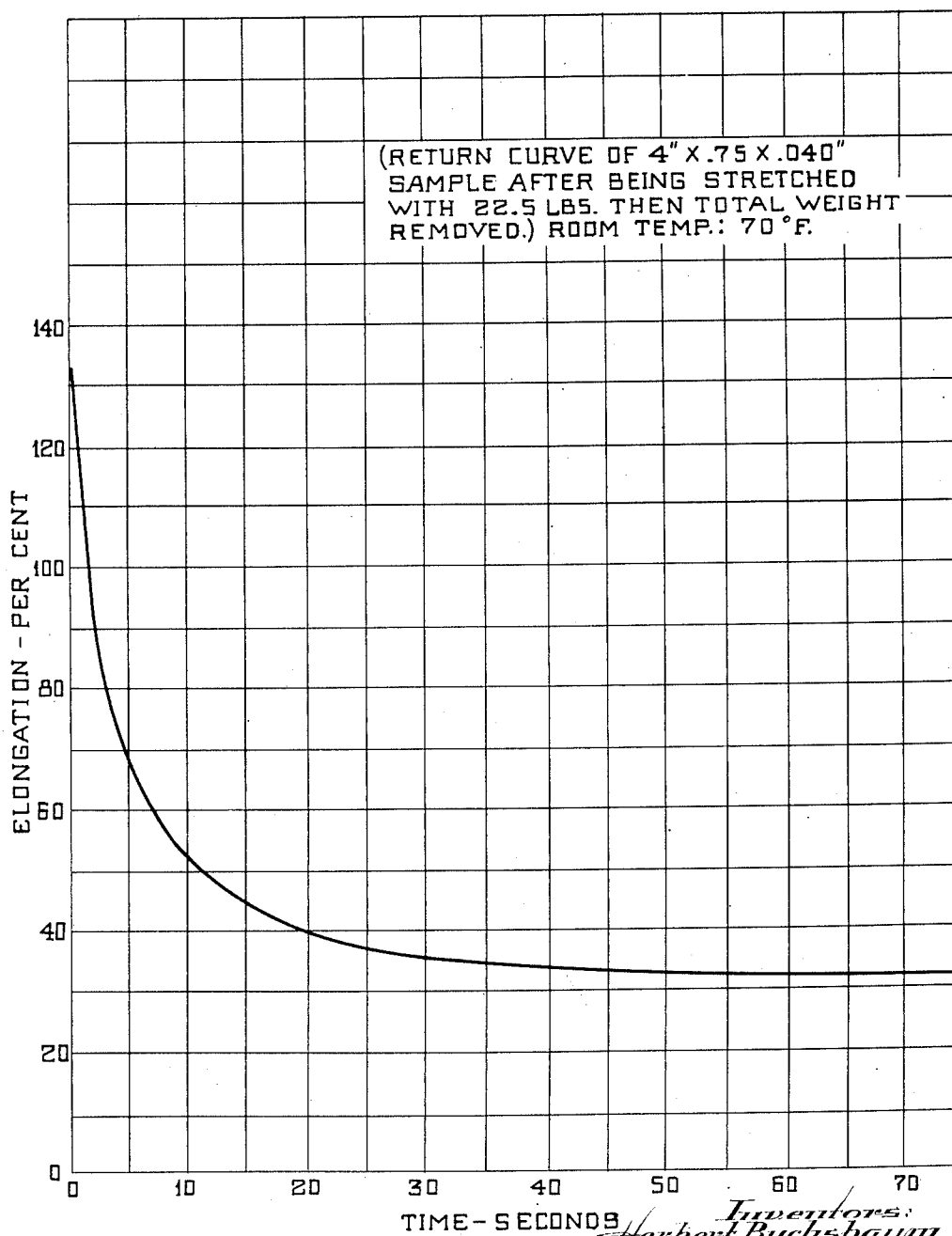
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4 Sheets-Sheet 3

FIG. 3.



TIME - SECONDS

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4 Sheets-Sheet 4

Fig. 4.

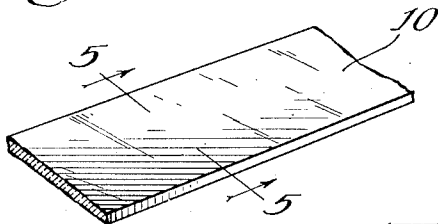


Fig. 5.



Fig. 6.

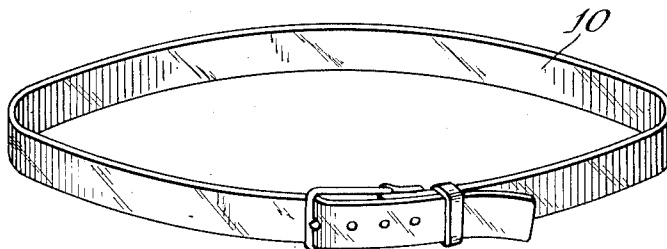
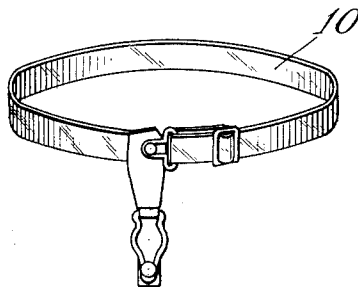


Fig. 7.



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UNITED STATES PATENT OFFICE

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Application February 8, 1940, Serial No. 318,006

2 Claims. (Cl. 2—243)

The invention relates to articles of wearing apparel, accessories and the like, which when worn or otherwise used, constrict, press or pull against the wearer or other user, either continuously, intermittently or occasionally. The invention has particular reference to articles of apparel such as stockings, belts, garters, suspenders and girdles, which normally continuously constrict, press or pull against the wearer. Such articles are normally worn in a stretched condition and may further extend or contract on movements of the wearer. The invention also includes and has advantages in handbags, brief cases and other luggage which may press against the hands of the user when the luggage is stretched in order to add or remove articles from the nearly full luggage. The invention may likewise include articles such as boots and shoes, rain-coats and capes, and other apparel which sometimes, at least, constrict, press, or pull against the wearer as, for example, during adjustment of the article to conform to the foot or body of the user.

In the claims, the term "body constricting type of supporter" is used to describe articles of apparel such as belts, garters, girdles, suspenders and the like, which during normal use are worn under tension over a part of the body.

Heretofore articles of apparel which are subjected to extensive stretching have generally been made of rubber. For example, garment supporters made of rubber have the advantage of remaining tense and of holding garments in place through a wide range of stresses such as are set up during movement of the wearer. However, such articles made of rubber must be stretched to a considerable degree at all times in order that the tension be sufficient to hold the garment. This results in a certain amount of binding or pulling against the body of the wearer. This discomfort caused by such supporter type rubber articles is a disadvantage which the art has accepted for many years.

Another disadvantage of supporter type articles made of rubber is that when the articles are in their normal stretched position slight and sudden changes in stress which may be immediately relieved cause an immediate and sometimes wide change in the shape of the apparel, as for example, a quick lengthening and narrowing of a belt or suspender strap.

Likewise, when brief cases and like containers made of rubber are stretched in order to add to the contents, the quick return of the rubber after stress has been removed is a disadvantage. In most cases, the user places his hand in the container in order to stretch it so as to add or remove articles. The contraction of the rubber walls of the container against the hand is so sudden that the hand undergoes consider-

able discomfort before it can be removed. After removal of the hand the walls must again be stretched and will again quickly contract for each article that is added or removed.

Furthermore, articles adapted to be stretched which are fabricated from rubber filaments or threads have the same disadvantages as articles fabricated from sheets. Thus hosiery knitted from rubber threads is objectionable from the point of view of comfort and appearance.

We realized that these and other objectionable features of rubber belts, suspenders, garters, brief cases and like articles could be overcome by making the article of an elastic material which has a sluggish or "lazy" stretch for a substantial distance when placed under stress, and also a slow return to its original dimensions when the stress is removed. In other words, the ideal material is a material which is capable of stretching a considerable distance, which stretches under a given stress over a given distance much more slowly than any rubber which has hitherto been used for the same purpose, and which also has a slow though persistent return to its original dimensions when external stress is removed.

The material in suitable and customary thickness and widths for belts, straps, etc., should also be capable of withstanding the ordinary maximum stress produced by the user during normal usage, yet capable of stretching a substantial distance under a stress much smaller than the maximum which the user exerts during normal usage.

In accordance with our invention, suitable materials for articles subject to stretching such as belts, suspenders and garters are materials having an ultimate tensile strength of at least 500 pounds per sq. inch, and which under a tensile stress of 1000 pounds per sq. inch should stretch 100% of its length within the elastic limit in a period of at least 5 seconds. On removal of the said tensile stress, the material should also return substantially to its original dimensions and require a period of from 3 to 30 seconds to return from 100% to 50% its original dimensions.

Preferably the material should have an ultimate tensile strength of at least 1000 pounds per sq. inch, an elastic extensibility of at least 100% of its length, and should require a tensile stress of not more than 2500 lbs. per sq. inch to produce 50% strain starting from zero strain. Under a tensile stress of 1000 pounds, the material should stretch 100% of its length within the elastic limit in a period of at least 10 seconds. On removal of the tensile stress, the material should also return substantially to its original dimensions and require a period to return from 100% to 50% of its original dimensions of

from 5 to 20 seconds. For preferred results the stress-strain diagram should substantially be that shown in curve 1 of Fig. 1; the elongation-time diagram substantially of the type shown in Fig. 2, and the return-time diagram substantially of the type shown in Fig. 3.

It required considerable experimenting and testing to obtain materials having the required stress-strain-time characteristics together with suitable properties of odor, appearance, and non-tackiness throughout a wide range of temperatures. A material which was determined to be very suitable is composed essentially of a vinyl resin such as a conjoint polymer of a vinyl chloride and vinyl acetate admixed with a minor proportion of a plasticizer.

The preferred vinyl resins are the conjoint polymers of vinyl chloride and vinyl acetate described in Reid Patent 1,935,577, in which the vinyl chloride is present in major amount compared with the vinyl acetate.

Suitable and preferred proportions of plasticizer will vary somewhat with the type of vinyl resin and the type of plasticizer. In general the amount and type of plasticizer should be such as to give a vinyl resin composition which is non-tacky and which has substantial flexibility and elastic extensibility at normal room temperature, and preferably between temperatures of 0° F. to 100° F. Also the character and amount of plasticizer should not cause decrease in tensile strength to below 500 lbs. per sq. inch, and preferably not below 1000 lbs. per square inch. On the other hand, sufficient plasticizer should preferably be present so that the tensile strength is not more than 2500 lbs. per sq. inch to produce at least 20% strain. A suitable ultimate tensile strength for vinyl resin compositions is approximately 1400 lbs. per sq. inch based on the original cross section, or 3500 lbs. per sq. inch based on final cross section at break.

The invention is further illustrated in the accompanying drawings, wherein

Fig. 4 is a fragmentary perspective view of a belt or garter made of a material (designated by the reference character 10) having the characteristics set forth in Examples I and II;

Fig. 5 is a section taken along line 5—5 of Fig. 4;

Fig. 6 is a perspective view of a belt made in accordance with Examples I and II;

Fig. 7 is a perspective view of a garter made in accordance with Examples I and II.

The following examples illustrate compositions which have been found satisfactory for supporter type articles and other articles adapted to be stretched, but it is not desired to limit the invention to materials made of such specific compositions.

EXAMPLE I

	Per cent by weight
Dimethoxy ethyl phthalate ("methox")	20
Dibutyl sebacate	7
Vinyl resin	73

The materials in the above formula were compounded on a mill, calendered into sheets of suitable thickness, and then cut to the desired dimensions for a belt, garter or suspender. The sheets and articles made therefrom were odorless, transparent, non-tacky, waterproof, perspiration-alcohol-proof, easily cleanable, and not capable of supporting combustion. They were tough and durable and would not scuff or crack even at temperatures of 0° F., or after long

periods of exposure to sunlight. Smooth, high gloss sheets of the material had a sliding coefficient of friction of .3249 at 68° F., when tested with a block wrapped with cotton broadcloth, as compared with a coefficient of friction for glass of .2867 and of soft vulcanized rubber (inner tubes) of .9004 tested under the same conditions. Physical tests on the material in strips having a width of .75 inch and thickness of .040 inch are shown in the following Tables I, II and III.

TABLE I
(See Fig. 1)

Weight, lbs.	Length, inch	Time, sec.	Lbs./in.	Percent elong.
0	4.12	0	0	0
2.5	4.87	120	83.3	18.2
5.0	5.37	240	166.6	30.3
7.5	5.75	360	250	39.5
12.5	6.62	480	416.6	60.6
17.5	7.25	600	583.2	75.9
22.5	8.25	720	749.8	100
27.5	8.87	840	916.4	115.2
32.5	9.37	960	1,083	132.0
37.5	10.37	1,080	1,249.6	151.7
42.5	11.0	1,200	1,416.2	167.0
	(Break)			

TABLE II
(See Fig. 2)

Weight, lbs.	Length, inch	Time, sec.	Lbs./in.	Percent elong.
0	4.37	0	0	0
10	6.87	5	333.3	57.2
	7.25	10		65.9
	7.37	15		68.6
	7.42	20		70
	7.50	25		71.1
	7.56	30		72.9
	7.62	35		74.3
0	4.37	0	0	0
20	7.25	10	666.6	65.9
	7.62	20		74.9
	7.87	30		80.0
	8.00	40		83.0
0	4.37	0	0	0
30	8.50	10	1000	94.5
	9.12	20		108.6
	9.37	30		114.4
	9.50	40		117.3
	9.56	50		118.9
	9.62	60		120.1

Original length—4.37 inches.

TABLE III
(See Fig. 3)

Weight, lbs.	Length, inch	Time, sec.	Lbs./in.	Percent elong.
22.5	9.30	0	749.8	132.5
0	6.1	10	0	52.5
	5.6	20	-----	40.00
	5.45	30	-----	36.25
	5.4	40	-----	35
	5.35	50	-----	33.5
	5.29	60	-----	32.25
	5.25	70	-----	31.25
	5.15	80	-----	28.75
	5.00	90	-----	25.0
	5.00	100	-----	25.0

Original length—4.0 inches.

The stress-strain diagram of this material is shown by curve 1 of Fig. 1, and differs from rubber as shown from the stress-strain diagram for a rubber carcass stock shown in curve 2 of Fig. 1. The curves of time against strain for given stresses are shown in Fig. 2. The return curve is shown in Fig. 3.

The proportions shown in the formula of Ex-

ample 1 are the preferred proportions. The ratio of dibutyl sebacate to "methox" of 7 to 20 has been found to give the best results consistent with lack of odor and suitable tensile strength. Increasing the proportion of dibutyl sebacate gives an odor to the material which may be objectionable. Both "methox" and dibutyl sebacate are plasticizers. "Methox" is odorless and dibutyl sebacate has an odor. However, the dibutyl sebacate lowers what is sometimes called the freezing point of the composition. When "methox" is used without dibutyl sebacate, the belts, suspenders and the like made from the composition are apt to crack on flexing at low temperatures, such as temperatures of 0° F., whereas with the dibutyl sebacate the belts and other articles may be flexed without cracking at such a low temperature.

The vinyl resin given in the formula of Example I was a conjoint polymer of vinyl chloride and vinyl acetate made in accordance with the Reid Patent 1,935,577, and included a small amount of basic stabilizer such as described in Grof Patent 1,966,856. The particular vinyl resin used was produced by conjointly polymerizing 80 parts by weight of vinyl chloride and 20 parts of vinyl acetate, and was about 75% insoluble in toluene at 25° C. It was admixed with 1 part of calcium stearate in 100 parts of resin. However, other conjoint polymers of vinyl chloride and vinyl acetate are suitable and include those ranging from 90% vinyl chloride and 10% vinyl acetate to 10% vinyl chloride and 90% vinyl acetate. Preferably, however, the proportion should be 70% or more of vinyl chloride and 30% or less of vinyl acetate with less than 30% of the resin being soluble in cold (25° to 30° C.) toluene.

The proportion of total plasticizer (dibutyl sebacate and "methox") to vinyl resin may vary quite widely. Belts, suspenders and garters having suitable "lazy" stretch characteristics may be made when the proportion of plasticizer to vinyl resin is as low as 21% and as high as 32%. Preferably, however, the proportion of plasticizer should not be lower than about 22% and higher than about 30% in order to obtain satisfactory elasticity and non-tackiness at temperatures from zero degrees Fahrenheit to 100° F. or such as are within the ordinary range of atmospheric conditions. The specific preferred proportion is that shown in the formula, namely, 27%, which has the physical characteristics heretofore indicated.

Another composition besides that shown in Example I which has been found suitable, is as follows:

EXAMPLE II

	Parts by weight
Triethylene glycol di-2-ethyl butyrate-----	25
Counter-odorant -----	Trace
Vinyl resin-----	75

This composition was compounded and made into belts in the same manner as described for the composition of Example I. The material had slightly higher tensile strength (2,000 lbs. per sq. in.) than the material of Example I, and was odoriferous but not objectionably so. Otherwise its characteristics and suitability was substantially the same as the material of Example I. The vinyl resin used was the same as in Example I. The range of suitable and preferred proportions of plasticizer to vinyl resin was slightly greater than for Example I.

Suitable and preferred proportions of plasticizer to vinyl resin will vary somewhat with the type of vinyl resin and the type of plasticizer. The proportions and type of plasticizer given in Examples I and II are merely illustrative of proportions and types which give suitable "lazy" stretch characteristics and are not intended to limit the invention to the specific proportions and kind of plasticizer shown.

The compositions may be made into articles of manufacture in various ways. In the case of belts, suspender straps, brief cases, handbags, boots, shoes, raincoats and capes, and the like, the composition is ordinarily calendered into sheets which are then cut to the required size and shape. These sheets may be single sheets or composite sheets laminated together and having tinsel or powdered glass between layers. The sheets and articles made therefrom may be transparent, or may be colored and translucent or opaque. The material may be given a smooth gloss finish by means of hot smooth polished platens, or other means. Such gloss surface improves the appearance and gives decreased frictional resistance to sliding, and are important advantages in garment supporters and other articles adapted to slide against the body or clothing.

The invention has particular advantages for articles which are normally in a state of elastic extension such as, for example, in the case of garment supporters which are being worn. Likewise, as has been hereinbefore pointed out, the "lazy" stretch characteristics are of advantage for brief cases, handbags and like containers. However, the "lazy" stretch characteristics are also of advantage in articles such as boots and shoes, rain-capes, and other apparel because of the ease in which such materials are made adjustable to the body of the wearer.

One of the greatest advantages of "lazy" stretch is in filaments or fibers and textile articles fabricated therefrom, particularly articles such as stockings which are under substantial elastic extension while being worn, and which extension is subject to intermittent large variations due to movements of the wearer.

The compositions described in this specification such as the compositions of Examples I and II, and compositions in which polyvinyl chloride is substituted for the vinyl resins used in Examples I and II, may be made into elastic filaments which, when fabricated into articles adapted to be stretched, give improved characteristics of stretch to the articles without causing discomfort to the wearer. The filaments have the same stress-strain and "lazy" stretch characteristics as the belts, garters, suspender straps and the like, made from the sheets and strips. The filaments have such strength and elasticity that single filaments of the diameter of ordinary thread used in making hosiery can be knitted into a stocking without twisting or doubling the filaments into a yarn or thread. The filaments are preferably made by heating the composition to a hot plastic molten condition, and then drawing a filament directly from the molten mass, cooling the filament, and winding it continuously on a moving drum or reel until the molten mass is exhausted. The diameter of the filament is regulated by controlling the rate of reeling. The higher the rate of reeling the finer will be the filament. The compositions which give "lazy" stretch are particularly suitable for carrying out this drawing process of making filaments in

which extrusion is not used at any stage of the process.

While the invention has been illustrated in examples in connection with the conjoint polymers of vinyl chloride and vinyl acetate, it may be carried out with other copolymers and other vinyl resins, including polyvinyl chloride and polyvinyl acetal, by regulating the type and amount of plasticizer to obtain the described characteristics. It is also contemplated that other elastomers or elasto resins may be used, as for example the elastic polymethacrylates, provided they have the described physical characteristics, or can be modified by means of plasticizers or otherwise to give the described physical characteristics. However, the hereinbefore described plasticized conjoint polymers of vinyl chloride and vinyl acetate give superior results for the purpose of this invention over any materials we have been able to find or make.

We do not desire to be limited to any theory as to the action of our vinyl resin. However, it is known that in the case of natural rubber the increase in elongation for relatively small expenditure of energy is only very small but above a well defined range of deformation the increase suddenly becomes very large. In the case of our plasticized vinyl resin, the relation is just the opposite for here the increase in elongation is at first relatively great and then becomes slow. This is shown in the stress-strain curves of Fig. 1. Materials having these properties of giving large changes in elongation with low stress at the beginning of stretch and of giving only slight changes in elongation with relatively high stress near the limit of stretch, are particularly suitable for belts, suspenders and the like, where after an initial stretch is made it is desired to keep further stretch as low as possible.

We also believe that the damping effect obtained with our material has a great deal to do with its value for belts, suspenders and the like articles. This damping effect, according to our view, is due to the fact that in order to stretch our material it is necessary to overcome a high resistance to plastic flow as well as the inherent elastic restoring force of the material. Our material seems to have plastic flow when placed under stress, and this type of flow, combined with a high resistance to plastic flow, gives what is called a "lazy" stretch or damping action. The damping action is similar to that obtained when closed cell sponge rubber is extended, the extension being resisted by the compression of the air in the cells, as well as by the inherent elastic restoring force. In our material, however, (un-

like sponge rubber) when the tensile force is removed the material returns slowly to original dimensions. This slow return action is also of high comfort value in belts, suspenders and like apparel, and is believed due to the fact that in order to return to its original dimension the material must overcome a high resistance to plastic flow which is nearly equal to the elastic restoring force, whereas with ordinary stretch soft vulcanized rubber the resistance or return to substantially original size is very small, compared to the elastic restoring force.

While there have been shown and described certain embodiments of the invention, it is to be understood that it is capable of many modifications. Changes, therefore, may be made without departing from the spirit and scope of the invention as described in the appended claims, in which it is the intention to claim all novelty inherent in the invention as broadly as possible, in view of the prior art.

We claim:

1. In a body constricting type of garment supporter, a gloss surfaced strap consisting essentially of a vinyl resin, which is a co-polymer of vinyl chloride and vinyl acetate, and a plasticizer, the vinyl resin and plasticizer being of such character and present in such amount as to give a composition which is non-tacky and has substantial flexibility and elastic extensibility over a temperature range of 0° F. to 100° F., said strap being further characterized by a relatively slow return to zero elongation after substantial elastic extension, and a relatively low coefficient of friction compared to vulcanized soft rubber strap of equal tensile strength and surface smoothness tested under comparable conditions.
2. In a body constricting type of supporter which in normal use completely encircles a portion of the body of the wearer, a gloss surfaced strap consisting essentially of a vinyl resin, which is a co-polymer of vinyl chloride and vinyl acetate, and a plasticizer, the vinyl resin and plasticizer being of such character and present in such amount as to give a composition which is non-tacky and has substantial flexibility and elastic extensibility over a temperature range of 0° F. to 100° F., said strap being further characterized by a relatively slow return to zero elongation after substantial elastic extension, and a relatively low coefficient of friction compared to vulcanized soft rubber strap of equal tensile strength and surface smoothness tested under comparable conditions.

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