Film-Tech

The information contained in this Adobe Acrobat pdf file is provided at your own risk and good judgment.

These manuals are designed to facilitate the exchange of information related to cinema projection and film handling, with no warranties nor obligations from the authors, for qualified field service engineers.

If you are not a qualified technician, please make no adjuatments to anything you may read about in these Adobe manual downloads

www.film-tech.com

TECHNICAL INFORMATION

for Projectionists

Published by **G.B-KALEE, LTD.** **No. 6**

PROBLEMS of SAFETY STOCK

By **R. Howard Cricks.**, *F.B.K.S., F.R.P.S.*

Projectionists who show the Festival of Britain film, " The Magic Box," will find many of the sequences of technical interest. Among the earlier problems of William Friese-Greene in the invention of kinematography was to provide a material suitable for coating his emulsion upon, and for running through his camera. In one sequence we see him, amid noxious fumes, producing thin strips, 6 ins. wide, from large blocks of celluloid.

Celluloid is in many respects a very suitable substance for use as a film base; but several tragic fires in the early days of the motion picture drew attention to its dangerous inflammability, and for half a century efforts have been made to find a non-inflammable substitute having acceptable mechanical properties.

The raw material of celluloid is cotton, and recent research has shown why it is so suitable: nature has in fact been doing for millions of years what science has only recently succeeded in achieving—in building matter into long molecules (some large enough to be photographed in the electron microscope) which are tangled together and produce a material of high tensile strength.

THE FIRST PLASTIC

Celluloid was in fact the first plastic, and it is only within the last few years that scientists have succeeded in producing synthetic plastics having similar properties —and so far none of these synthetic plastics has properties equal to those produced by nature.

In the manufacture of celluloid —or cellulose nitrate, as it is called chemically—the cotton is reacted with nitric acid. Now this process is very similar to the process by which gun-cotton is produced, and the fact that it results in a highly inflammable material is not therefore to be wondered at.

Other acids may be used. For many years we have had so-called acetate film, made by substituting acetic acid for nitric; other acids that can be used are propionic and butyric. But none of the resultant materials had formerly characteristics equal to those produced by nitric acid; on the other hand, the results were comparatively non-inflammable.

CHARACTERISTICS OF BASE

Kodak safety base marketed since 1937 has been produced by a mixture of acetic and propionic acids. The Gevaert stock is a butyrate.

The characteristics of the base depend also upon the degree of chemical reaction permitted. While early safety base was known as a di-acetate, the new Kodak safety base is known as a tri-acetate.

Note that we describe the new base as 'safety' rather than 'non-inflammable.' Safety base is in fact about as inflammable

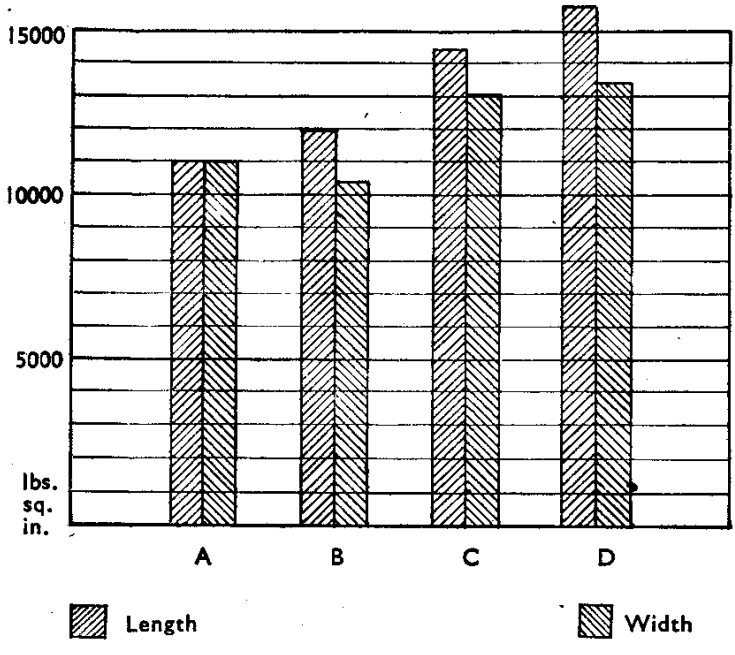

Fig. 1. *Tensile Strength of Kodak Film Stocks.* (a) *Acetate Base prior to* 1937. (b) *Acetate Propionate Base after* 1937. (c) *Tri-acetate Base.* (d) *Nitrate Base.*

as newspaper. Before the war the British Standards Institution issued a specification, No. 850:1939, which laid down two requirements of safety base: it shall be "difficult to ignite," which means to say that at a temperature of 300°C. it shall not ignite within ten minutes; and it shall be "slow burning."

For both requirements laboratory tests are laid down. A field test to indicate whether or not the film is "safety" makes use of a double-ended spoon; a ¼in. punching of nitrate film is placed in one bowl, and a similar punching of the film to be tested in the other, and in turn they are held in the flame of a candle. Nitrate film will ignite with explosive force, while safety base melts or burns slowly.

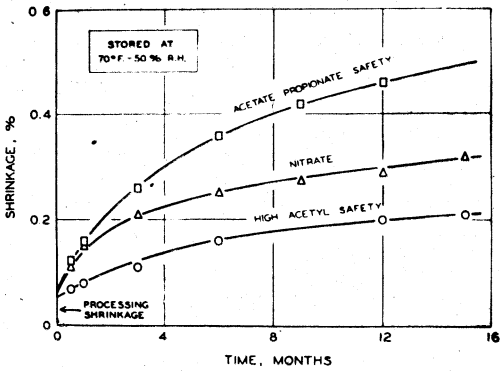

Fig. 3. *Shrinkage of Processed Film, stored in Circulating Air. — Courtesy of* British Kinematography.

STRENGTH AND FLEXIBILITY

Any projectionist who ran safety prints before the war will be well aware of the failings of the base. It tore very much more easily than nitrate, and quite soon became brittle. It was also difficult to splice; the use of glacial acetic acid was commonly recommended—too little failed to stick, too much buckled and rotted the film.

Technically the first two properties can be expressed in terms of tensile strength and flexibility. Fig. 1 shows the improvement in tensile strength, according to figures supplied by Kodak. It will be seen that the tri-acetate base is nearly the equal of nitrate, and much superior to either of its predecessors.

The brittleness or flexibility of a film must be considered not so much when it is new, as after it has had a certain amount of use. For the purpose of testing such properties, "accelerated ageing" tests are used, in which the film is kept at high temperatures, which it is reckoned produce the same effect as long-term storage at normal temperatures. The effect of such tests upon the flexibility of film base is shown in Fig. 2: nitrate, it will be seen, starts off rather more flexible than safety base, but rapidly becomes brittle; either form of safety base on the contrary retains its flexibility almost unaltered for a long period of time.

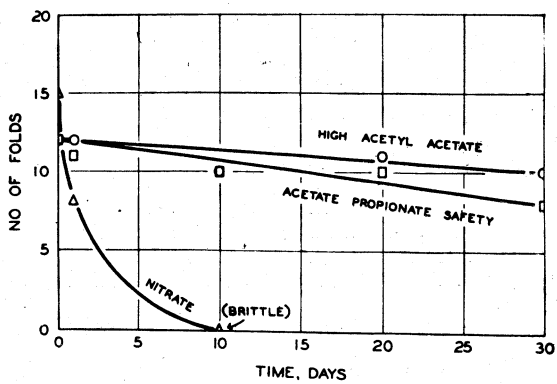

Fig. 2. *Retention of Flexibility of Film Base, measured by repeated Folding —Courtesy of* British Kinematography.

LIFE OF SAFETY BASE

We can therefore say that in tensile strength the new stock is practically the equal of nitrate, and in flexibility rather superior (the last is the reason why the new base feels so supple). But before we can say we are satisfied with the new base, two other factors have to be considered: what happens to it in the projector, and whether it can be joined easily.

Statistics show that 50% of all film damage reported by renters takes the form of scratching. The more serious form of scratching is on the emulsion, and as the emulsion on either base is identical there should be no difference whatever in this respect. As regards scratching of the base, this is no doubt a question of the hardness of the stock, and in this respect the new stock should be very little inferior to nitrate.

The second serious form of film damage is perforation tears and straining, which together account for 25% of reported damage. And here we come up against a feature of the new stock which, although to the manufacturer a decided advantage, may in practice prove to be a disadvantage. This factor is that safety base shows a much lower shrinkage than nitrate.

EFFECT OF LOW SHRINKAGE

The reason this is so important is that our film has to engage with the sprockets, and for accurate engagement the pitch of the sprockets should exactly match that of the film.

Fig. 3 shows the shrinkage of positive films over a period of 16 months. It will be seen that the shrinkage of acetate base is only about two-thirds that of nitrate. These figures are for film stored in free air—a test which differs markedly from the practical conditions of running through a hot projector a number of times, then being boxed up—probably while still warm —and shipped off to another kinema, where the films run through projectors of different type.

At my request Kodak recently made some measurements on a length of safety base which had been badly damaged in use—the perforations on one side were torn and on the other side badly strained. I hasten to add that the damage was obviously due primarily to a projector fault, but it is interesting to consider whether perforation pitch was an important factor.

The shrinkage of the film as it was removed from the container was 0.13%. After two hours conditioning at a temperature of 70°F and relative humidity of 60% (conditions similar to those of an average projection room) the shrinkage was only 0.04%. The shrinkage of nitrate base might well be four or five times as much.

In view of the importance of this matter, I have made the suggestion to the K.R.S. Print Condition Advisory Committee that tests should be made to ascertain the effect of this difference in pitch. My own view is that on a projector in perfect condition the effect will be slight, but any fault in the projector, and in particular emulsion pick-up in the gate, will impose additional strain upon the film, and lead to damage which in the case of nitrate might be avoided.

DIFFICULTY OF JOINING

Film cement does not act in the same way as paste joins two pieces of paper. It should be a solvent of the base, making a perfect weld. It appears that no such perfect solvent has yet been found for safety base. Experiments are proceeding in many directions, but in the meantime it is necessary for the projectionist—and the renters' examiner—to take every precaution, and to examine the splices of films on safety stock.

One point of difference from nitrate is that the cement takes longer to dry, and during the drying period the join must be kept under pressure. If only for this reason, therefore, a joining press of approved design is essential, and every rewind room should be so equipped. Two models have been approved by the C.E.A.

IDENTIFICATION of SAFETY BASE

A serious problem is the risk of confusion between nitrate and safety base. Not only is there the risk that a leader or reprints on nitrate may be cut into a print otherwise on safety; a number of projectionists have reported that stock bearing the words "Safety Film" has proved to be inflammable. The last is a source of real danger. It is due to the fact that a negative on safety stock bears the words

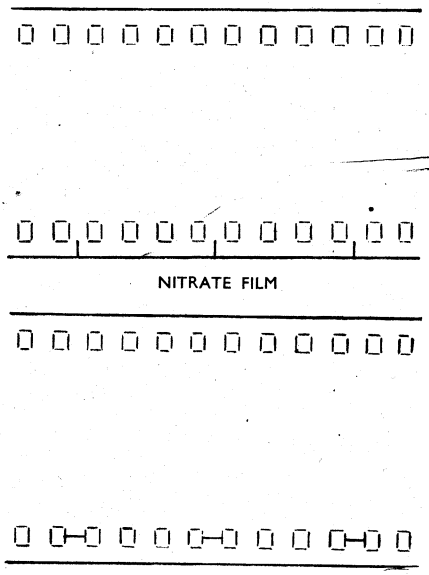

Fig. 4. *Eastman Kodak system of Identification of Film Base. Only Films showing the Marks between perforations, as in the lower sketch, are Safety.*

photographically printed in its margin; in the printing machine these words are imprinted upon the positive.

The original edge lettering always has black letters on a clear ground; if therefore the letters on a print are white on black, one can say definitely that they have been printed through from the negative. If however they are black on white, there is still the risk that they may have been printed through from the master positive from which the dupe negative is made.

Eastman Kodak in America have adopted a new system of identification shown in Fig. 4. A better idea has been introduced by Kodak in this country: instead of the plain line between perforations of safety

stock, appears the letter S. This portion of the film is not exposed in any form of printing machine, therefore so far as one can foresee, any film bearing either of these distinguishing marks must definitely be safety.

SAFETY REGULATIONS

One final point should be mentioned. It will be years before all nitrate prints are out of circulation, and during this time safety regulations will be just as strictly enforced. Not until every foot of nitrate film is out of circulation can regulations be relaxed.

It may indeed be suggested that while there remains the risk that prints mainly on safety base may have leaders, run-outs, or reprinted sections on nitrate, there exists an added element of danger. The projectionist will therefore be wise if for some years to come, he regards every reel of film as potentially inflammable, and exercises the same precautions to which he has in the past been accustomed.

The various devices which have been evolved in the cause of safety — close-fitting fire traps, efficiently working safety shutters, and automatic fire extinguishers — must on no account be scrapped. After all, if a fire were to occur, it would inevitably be on the one chance reel of nitrate.