

source, has been recorded. The lamp worked at 200 atmospheres and its temperature was estimated at 89,000° K. For the reason given above however, the life of such a lamp is only a matter of few minutes. The spectrum of this source shows considerably broadened lines with a continuous background.

The compact source M E type of lamp's high brightness, long life and useful optical characteristics makes it suitable for a variety of purposes. It is thus an admirable substitute for the carbon arc and being sealed in an enclosure is much cleaner to work with. These lamps are made in wattages varying from 100 watts to 25 kilowatts.

For use in the 16 mm. and other substandard film projectors as well as in lantern slides and episcopes projectors, the M E type mercury arcs give satisfactory performance. With the same power consumption as an incandescent filament lamp and at the same time reducing by half the amount of heating associated with it, a 250 or 500 watts lamp in a projector increases the screen illumination from 100-250 lumens to 250-1000 lumens per watt. For a high power 35 mm. standard cine projector the high pressure mercury lamp could be used, but compared with a modern high intensity carbon arc the chief drawback is its very short life of 25 hours. Colour rendering is also rather poor with these lamps.

**M C F:** This is the now common type of fluorescent lamp, the 40 and 80 watts units having a glass tube-length of 4 and 5 feet respectively. The lamp differs from all the rest in that it works at a very low mercury vapour pressure of 0.015 mm. Its unusual length as an ordinary illuminant is a consequence of the very low potential gradient of 1 volt per cm. necessary to maintain the tube at a low temperature not exceeding 60° C., for it is at about this optimum temperature that the intensity of the fluorescent light from the powders is at a maximum. The lamp through the agency of the ultra-violet light at the wavelength 2537 Å raises its original luminous efficiency from 5 to 35 lumens per watt, which is nearly three times greater than an incandescent filament light. This combined with a life which is also three times greater, (3,000 hours) more than compensates the high initial cost of the lamp. For home lighting either in the cool 'day-light' form or in the

'warm white' form, it would be therefore cheaper to have this type of lights which are now available in wattages varying from 6 to 80. Thus a 15 watt fluorescent lamp may be substituted for an ordinary 40 watt incandescent filament lamp, the total number of lumens obtained in each case being  $15 \times 35 = 525$  and  $12 \times 40 = 480$ , respectively.

As sources of high actinic value, the M A, M B as well as the M C F mercury lamps have proved useful and economical in all types of photographic and photomechanical work such as copying, printing and enlarging and for photographic, movie and television studios.

For photography under poor illumination and for high speed photography in the study of motion, light-flashes of high intensity and durations ranging from a few milliseconds to a few microseconds, according to the motion of the object and speed of the camera shutter, are necessary. The old magnesium burning technique was replaced in 1930 by the American photoflash bulbs containing thin aluminium foil and oxygen. Such lamps which run on dry cells are useful only once, but they are still used. They give a total light output of the order of a million lumens while the least duration of the flash is 5 milliseconds above the half peak value.

The advantages of an electric discharge flash-lamp over the last one are that it could be repeatedly used while the intensity of light as well as the duration of the flash and the interval between successive flashes could be all conveniently controlled by suitably changing the current conditions of one of the high pressure type of mercury lamp. Synchronisation with the shutter speed is also easily obtained. A further advance in flash photography has been however made by the stroboscopic discharge lamps which give flashes of 10-100 microseconds duration through a condenser discharge in mercury vapour or in one of the rare gases.

With a wealth of information given only in its bare outline here, it would be hardly necessary to add that this treatise on discharge lamps would be eagerly sought for by the technical reader who wants to know any thing about the mercury vapour lamp—a lamp more wonderful than the Alladin's.

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## TONUS IN UNSTRIATED MUSCLE

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**T**ONUS in unstriated muscle has been variously explained. It has been ascribed to a catch mechanism<sup>1,2</sup> or to increase in viscosity.<sup>3,4,5,6</sup>

There are two kinds of tone<sup>7</sup>. During one the oxygen consumption increases<sup>8</sup> and during the other it decreases.<sup>8,9</sup> Similarly there are two kinds of inhibition, during one the oxygen consumption increases and during the other it decreases.<sup>8</sup> Correspondingly it has been found that as a result of asphyxia or treat-

ment with cyanide, tone may increase or decrease.<sup>10,11,12,13</sup>

The asphyxial contraction is decreased by oxygen as well as by glucose.<sup>10,14</sup> The action of glucose is antagonised by iodoacetic acid. Thus energy is required to keep the muscle elongated. The normal contractions of unstriated muscle are produced on a background of inhibition. This is also shown by the action of iodoacetic acid which abolishes this inhibition and causes the muscle to contract. The

contractions of unstriated muscle are then produced on a background of tonus. The asphyxial contraction may provisionally be termed "alactic" tone in contrast to the other tone which is increased by oxygen and glucose — "lactic" tone. It cannot however definitely be said that the former tone only develops when lactic acid production fails or that the latter tone derives its energy only from the production of lactic acid.

When the asphyxial contraction has maximally developed, the muscle still responds to electric current, potassium and acetylcholine, through inhibition by adrenaline, cannot be produced. This shows that the asphyxial contraction is not due to depletion of the entire energy reserves of the muscle.

The inhibitory action of glucose on the asphyxial contraction is temporary. It causes a fundamental change in the properties of the muscle. In its absence, oxygen inhibits the asphyxial contraction, but in its presence it has the opposite action. Thus if glucose is added when the asphyxial tension is rising, after a short period of inhibition, the tension may continue to rise and oxygen now further increases the tension. If the muscle is now asphyxiated, the tension built by the alactic mechanism is lost by the lactic mechanism during asphyxiation. The taking-over by the lactic from the alactic mechanism may be immediate, in which case the inhibitory action of glucose is not apparent.

The chief properties of the asphyxial contraction are (1) that it does not diminish on exclusion of oxygen or addition of sodium cyanide (1 in 10,000). (2) It is converted into lactic tone by glucose. These two properties are shown by muscle removed freshly from an animal. Such a contraction is produced by stimulation with direct current, potassium, barium, iodide, thiocyanate, acetylcholine, even in the presence of oxygen. The contraction produced by iodoacetic acid also does not diminish on the exclusion of oxygen. This suggests that the "asphyxial" contraction is a normal phenomenon and is the tone by means of which unstriated muscle is able to maintain tension without expenditure of energy.

One characteristic of unstriated muscle is slow relaxation. If the muscle is asphyxiated in the presence of a stimulant such as potassium, the withdrawal of potassium does not cause the muscle to relax, as it does in the presence of oxygen. The muscle now relaxes slowly. The properties of this slow relaxation are identical with those of asphyxial contraction or alactic tone. Such slow relaxation is produced even in the presence of oxygen and we have found cyanide and asphyxia to be the most powerful agents in causing such slow relaxation.

Different muscles are affected differently by asphyxia. In the fowl's gut muscle, the asphyxial contraction is hardly noticeable, but

the action of glucose shows that it has passed into the "asphyxial state", even though the muscle is relaxed. In frog's stomach muscle oxygen has inhibitory effect on the asphyxial contraction, but in the dog's stomach muscle the effect is less marked. In the frog's stomach muscle, the action of glucose is less marked than in dog's stomach muscle. The normal tone in unstriated muscle is a mixture of lactic and alactic tones. In some muscles, such as the fowl's gut muscle lactic tone predominates, in dog's stomach muscle the alactic tone predominates.

The above view of tonus in unstriated muscle is supported by the phenomenon of active elongation.<sup>15, 16, 17</sup> In dog's stomach muscle, active elongation of a twitch contraction occurs. In frog's stomach muscle active elongation of a normal tonic contraction occurs.

The above experiments show that tonus in unstriated muscle is due to contraction. The question arises, how can production of lactic acid cause relaxation and contraction at the same time? It appears that in the muscle there are two different proteins, which are acted upon differently by production of lactic acid, or in the same protein, there are chemical groupings so acted upon. If energy is required to keep the muscle relaxed, the increased oxygen consumption may be due to greater effort at relaxation during contraction. During twitch contraction such an effort might occur, but not during tonic contraction, thus accounting for the difference in oxygen consumption during the two kinds of contraction. It appears that the excitatory and inhibitory processes occur simultaneously, and this perhaps accounts for the existence of a dual nerve supply to unstriated muscle.

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