The following outstanding article on Interval Training appeared in the March, 1956 issue of Track & Field News. Since this issue is out of print the information is now offered in reprint form.

# INTERVAL TRAINING

(Note: Modern training methods are universally credited with the tremendous progress in world distance running standards. This article, reprinted by courtesy of "Scholastic Coach", is an excellent summary and analysis of these methods and the reasons for them, and is an important contribution to the sport. "Fartlek", the training system mentioned herein, is described in a series of articles published in "Track & Field News". Reprints of the series are available for $1.00)

by Ken Doherty

Apparently every distance runner and coach in Europe is now using some form of interval training in his preparation for competition. The great Hungarian trio of Iharos Tabori, and Rozsavolgyi, under their martinet coach, Mihaly Igloi, are following its tenets faithfully and intensively.

I sat this past summer with Armas Valste, Finnish National Coach, as he timed his fine 10,000 meter runner, H. Posti, through six 660 yard runs at between 1:30 and 1:35 each, within a total of 30 minutes. In a book which every American distance runner and coach should read, FRANZ STAMPFL ON RUNNING, the author advocates interval training as the core of modern running: "One of the main charms of interval training is its flexibility, since it can be adapted to the varying needs of all athletes at any stage of development. It induces speed and stamina, which together produce pace, pace judgement, and an all-round improvement in physical well-being."

Similarly, Roger Bannister found that interval training answered his needs: "In February and March (1953) I started track training, and would sometimes run as many as ten quarter miles, each in about 63 seconds, and with an interval of two or three minutes between each. This was much more strenuous training than I had done before. It left me exhausted for several days, but it could be accomplished within the half-hour or so a day that I was able to spare for training."

The list could be lengthened indefinitely: Moens of Belgium (800 meters, 1:45.7), Chataway of England (mile, 3:59.8), Boysen of Norway (800 meters, 1:45.9), Pirie of England (10,000 meters, 29:19), Nielsen of Denmark (1500 meters, 3:40.8), and, to add one of many Americans, Courtney of Fordham (800 meters, 1:46.8). Each of these men places his own particular emphasis upon the various aspects of interval training, yet all follow a basic plan.

It is essential to understand that there are four variables in interval training: (1) an exact repeated distance that remains unchanged in any single workout; (2) a recovery interval of time during which restful jogging occurs; (3) a pace at which the distance is covered, always under a watch; and (4) the number of times that this distance is repeated. It will be quickly seen that each of these elements can be stressed or lessened, fixed or varied in accordance with the ability, condition, and attitude of each runner or with the particular point of view of the coach. Franz Stampfl, for example, seems to feel that stamina is the primary element in successful running today, and advocates a program in which many repetitions at a slower than racing pace is the principle workout during an eight month training program. In contrast, both Valste as cited earlier and

Gosse Holmer, Swedish National Coach, emphasize speed work. Swedish champions, in addtion to the many fast bursts in "Fartlek", often train on 400 meters and 200 meter runs at faster than racing pace.

Since returning from Europe, the writer has tried to think through his many conversations on this subject and to adapt what he learned to the problems of American school and college runners. There has been opportunity to experiment on the track during only a few weeks of post-cross-country training (written December, 1955), but the following set of principles and plan for interval training, subject to many later refinements, already seems to make sense not only to this coach but, more importantly, to his runners as well.

First, and this is a principle of growing importance, a coach is not a trainer of human puppets who follow his every command and demonstrate his worth through their outstanding performances; rather he is an advisor, a guidance counselor, or at most a supervisor. He helps men to do better what they are quite capable of doing well alone. He guides men in discovering themselves, or better, in discovering powers of endurance and skill and self-discipline beyond what they alone might have realized.

The second principle is that only year-round training can produce the high level of running fitness and competitive performance that is required for success at all levels. This is as true for high school, college, and post-college training as for the training of Olympic placewinners; the only difference is one of amount of work done, not of method. At first consideration this principle smacks of over emphasis and over-specialization, but in the light of what follows it will be seen to be the only practical means of doing one's best within the limitations imposed by the amateur ideal and educational and vocational requirements. Further it is an important answer to the general lack of physical fitness among American men which has created so much concern lately.

Third, amateur ideals and the requirements of school and college studies demand (the word is chosen carefully and does not over-emphasize) demand that workouts should not consume more than 90 minutes (and better only 60 minutes) on the track, nor produce such fatigue that recovery is not complete within two hours following the workout. Within an hour after practice a man should be able to concentrate his mind upon his studies without the handicap of physical fatigue.

Fourth, year-round training, even when these limits in time and fatigue are accepted, emphasizes a gradual increase in the amount of work that can be done, so that, month by month, year by year, performance levels in both practice and competition gradually improve and ultimately reach heights that are impossible for the traditional short-season, practice-to-exhaustion runner.

Stampfl: "There is no limit to the achievements of the man who responds gladly and cheerfully to the rigorous demands of a tough training schedule, who does not look for miracle transformations, but is patiently content with the slow but well-founded progress which emerges. Constant regular training not only toughens him physically by strengthening his muscles, developing his lungs and heart and improving his blood circulation, but heightens his perception and teaches him to perform every movement with the greatest economy of effort."

Fifth, year-round training assumes a reasonable, one might almost say a normal enjoyment of the pleasures of life. During periods of important competition, the essentials of healthful living: proper rest and relaxation, a well-balanced and moderate diet, and "no activity to excess" become increasingly important of course. But excessive emphasis over a long period of time upon the exact requirements of off-the-tract training will not only produce a boring existence for the runner and his associates, it will bring staleness and a decreased performance as well.

Sixth, such a program of year-round, intelligent, and gradually intensified training contributes to the positive health of the runner and certainly does not "tear him down","shorten his life-span", or "strain his heart" in any way. Staleness can result from too much work too soon, from too strict off-the-track training, or from the mounting tensions of too long a competitive season, but it is not the result of too much work per se, or of too many months of training.

With these six principles as a guide, a coach is justified in asking students, either high school or college, to report to the first cross-country workout on the first day of the school year "in condition". They can still experience all the reasonable enjoyments and relaxation of vacation, and yet have a background of running: on the beach, on the city sidewalks, somewhere, sometime, each day. A week or so of preliminary "easy" work on the cross-country course will then prepare the way for the faster running that is so essential. Swedish "Fartlek" is one of the best plans to follow, with its interesting variation of pace up and down hills, with fast running whenever the group "feels like it" or when the ground surface permits. American coaches vary a great deal in the extent to which they use "Fartlek" in training for competitive cross-country, but it is certain that, from a physical standpoint, "Fartlek" can be a much more strenuous form of training than is the traditional even-paced running. Yet, because of its freedom from the stop watch and the demands of an exact distance and an exacting coach, it creates little of the tension and resistance that methods to "hurry" conditioning by time trials under the watch tend to do.

Even when the cross-country season has been intensely competitive and rigorous, men following a "Fartlek" and interval training program will need only a week or so of"rest"; in fact, many simply transfer their clothes to the track locker room and continue daily running without question.

A planned program of interval training can be started immediately. Physically the men have just the right background for it and mentally it is the most interesting of all track training programs. Above all, it is important that each man have a clear understanding of his own program, not merely what he is doing but why he is doing it. No coach can do as good a job of assigning work on the basis of his own judgement alone as can a well-informed and thoughtful runner working with the advice of an intelligent coach. Together they afford broad experience and judgement plus an intimate knowledge of so many details which only the runner himself can possess; separately, some essential of this important "whole" is certain to be missing.

Runners should understand, first, that conditioning for running is primarily a matter of building resestance to the many effects of fatigue (production of lactic acid, lowered oxygen supply to the muscles, decreased sensitivity of muscle fibers to stimuli, etc.). This is done by gradually increasing, as muscle efficiency improves, the amount of work that is done, much as one gives increasing dosages of vaccine in building resistance against certain diseases. As with various vaccines, nature overcompensates or over-protects and creates a counteracting force beyond the needs of the moment. This gradual increase in work-load, with resultant over-

compensation, continues indefinitely through the months of a single year and through the years of man's competitive career. If done gradually, no strain of muscle of organ occurs; yet in time the power to neutralize that can be established is amazingly high; even today we do not seem to be approaching the limits of men in their ability to benefit from more and more of the right kind of running.

The efficiency of running, in terms of fatigue, decreases to the 4th power as pace increases. That is, if we double the speed of running, the oxygen requirement of muscle increases eight times. It is easily understood then, that when practice time is limited as with most amateurs and students, doing speed work in practice produces fatigue and, as an outcome, an increased resistance to fatigue, much more quickly than slower paced running. Further, it has been observed that in slower pace running, men are more conscious of the feeling of fatigue and tend to slow their pace before becoming really tired physically. For these and other good reasons, distance training has gradually made increasing use of practice runs that are faster than competitive pace. Thirty years ago, we called such a method, "ins and outs"; later it became "wind sprints"; ten years ago everyone was doing "repeated speed work"; even Fartlek is a more modern use of this same idea.

Today's terminology, "interval training", is merely a carefully organized and well thought out adaptation of this same basic principle. At the beginning of this article four variables were mentioned that occur in interval training: distance, recovery interval, pace, and number of repetitions. Each of these must be carefully weighed when setting up a program. What distance should a miler select for his basic training; something over a mile, one mile, 3/4 mile, 1/2 mile, 440, or a 220? No one distance meets all needs; each has certain advantages and disadvantages. To train at a distance of over 3/4 mile means that the pace must be slower than competitive pace or that the recovery interval must be very long. Most coaches believe this to be undesirable. On the other hand, pace work at 880 yards provides a more satisfactory sense of continuous rhythm than does a shorter distance.

In similar fashion, what recovery interval of jogging is best: one minute, two, three, five, twenty? There is no general or final answer to this. Stampfl suggests that the interval should be long enough "for each fast run to be begun comparatively freshly". This would mean that, if running ten repeated quarters, the recovery period should be lengthened as fatigue increases during the workout. This would defeat one of the basic purposes in interval training: the building of greater resistance to gradually increasing work-loads. To the best of our knowledge, no distance runner follows such a method. Most runners have arbitrarily adopted two minutes or three minutes or even five minutes as the most productive rest interval, depending upon the distance and speed of each repeated run.

Perhaps it is worthwhile to interrupt at this point in order to emphasize the fact that very relaxed jogging is the best possible method of making rapid recovery from fatigue as well as of avoiding muscle stiffness or soreness. Blood circulation and other processes of recovery are thus maintained at optimum levels.

Yet in at least one instance there are values in extending this recovery interval to as much as 30 minutes. When running fitness is at a high level, a man may wish to run half or three-quarters of his racing distance at racing speed or even faster. Recovery now requires a longer interval of jogging. For example, the

writer noted every detail of this workout taken by Gordon Pirie on September 1, 1955, at the height of his training for the 10,000 meters;

(1) 30 minutes of warm-up (jogging with many easy wind-sprints and a few exercises.)
(2) A mile in 4:11.5 (3) 30 minutes of jogging
(4) A mile in 4:15.8 (5) 30 minutes of jogging
(6) A mile in 4:18.9 (7) 30 minutes of jogging

Pirie believes there are benefits derived, when one is in excellent condition, from this type of workout which could never result if the time interval were arbitrarily maintained at five minutes or less. Stampfl calls this procedure "repetition" running to distinguish it from the more common term "interval running". The difference in meaning does not seem clear to the writer, hence his preference for the expression, "long-interval training" as contrasted with "short-interval training". Long-interval training provides a tough workout, demanding great stamina from one's body, but equally, great toughness of mind toward the feelings of fatigue that are certain to be evident. It is this kind of toughness that puts one foot in front of the other when, in a highly competitive race, physical energies are apparently exhausted and only the will to go on seems to make further effort possible. For these reasons, all-out long-interval training should be reserved for the later stages of the season.

To return to short-interval training, the writer has found it helpful to consider two types of workouts: pace-endurance work and speed-endurance work. In the first instance, the three factors of distance, interval, and pace are held constant; the fourth factor, number of repetitions, is constantly increased as condition improves. For example, a miler believes that by the end of the year he will be able to run a mile in 4:16, an average of 64 seconds per quarter. He will therefore establish this as the pace at which he will do all pace-endurance work. Secondly, he decides that about half the racing distance is best when training for pace, so his practice distance is established at 880 yards. Third, since his practice time is limited to about 60 minutes, and since he guesses he will not be able this year to run more than four or five such 880's in a single workout, he arbitrarily decides upon five minutes of jogging as his rest interval. Early in the season, then, this miler will run as many 880's as he reasonably can (perhaps two or at most 3) at a pace of 2:08, with a five-minute interval between each. Late in this same year, when taking this type of pace-endurance workout, this miler will still be doing this identical workout except that now his improved condition permits him to run three, four, or even five such 880's. Such a method permits a measurement of improvement from week to week and month to month which is just as sensitive and exact in its way as is the single formal time trial over a set distance. Obviously all running and all jogging is checked by a watch and is recorded in detail for future reference.

The second type of short-interval training is called speed-endurance work. In this case the three fixed factors are distance, interval, and number of repetitions; the variable is now pace. For this workout, one-fourth the competitive distance seems best. For this reason, the interval can be shortened to three minutes. A longer interval gives too much recovery and too long a total workout before fatigue occurs. Again, rather arbitrarily, the number of repetitions is set at five. This means the total distance covered under the watch (5 x 440 yards) is greater than racing distance, a worthwhile realization. (A more mature runner might decide that seven is a more optimum number of repetitions.) During early season then, this same miler who hopes to run 4:16 this year repeats five 440s with

3 minutes of jogging between at an average speed of, say, 66 or 68 seconds. During late season he is still covering this same schedule, but now can achieve an average of 60 seconds, a pace that is definitely faster than racing speed. Two weeks before Bannister ran his first better-than-four-minutes mile, he was pleased to achieve ten 440s at an average speed of 58.9 during a total time of 50 minutes. This performance seemed to convince him that his condition was excellent almost as much as did a 3/4 mile solo time trial in 2:59.9 in a high wind some six days later.

Is there a special value in the exact distance of 440 yards? Not at all, physically speaking. Johansson, the fine Finnish miler, prefers to practice at 350 yards. If all of our work were done on an eleven lap indoor track, an exact three laps (480 yards) might well be accepted. One uses 440 yards then because it is the distance of a single track lap, or because it is one-half or one-fourth, or one-eighth the racing distance. Further it is long enough to give one a sense of sustained running; yet short enough to permit much better than racing speed. There is no important reason, the, why a miler or even a two miler should not occasionally adopt the 220 yard distance for his speed-endurance workout. It permits increased variety and interest, allows all distance men from 440 yards to two milers to work together and does tend toward greater speeds.

Perhaps it is well to take time at this point to try to answer the question as to why speed is desirable and how it is best acquired. The need for speed during the final sprint to the tape is obvious; the more speed the better. Of course, the ability to run fast, of itself, will not necessarily permit a man to run fast when tired, at the end of an "all-out" seven-eighth of a mile, for example. Yet it seems logical, that of two men possessing equal stamina, the one possessing greater speed will have the faster finish.

But equally important, perhaps, physiologists suggest that there is a positive relationship between speed and endurance. In writing of strength-endurance, Morehouse states: "When a light load is moved by a muscle, fewer fibers need to be brought into play. The remaining fibers are at rest and stand ready to act if they are needed in succeeding contractions. As the working fibers become fatigued during light work, the threshold of irritability is raised and these fatigued fibers fail to respond to the stimuli. The stimuli pass into fresh fibers whose irritability threshold is low and the burden of the work is thus shifted to the fresh fibers in the muscle."

It seems logical that, within certain limits, the greater the number of fiber groups that can be utilized in this way, the greater the endurance of the muscle. The problem then becomes one of increasing the number of effective fibers. In untrained muscles there are many latent or inoperative fibers, small from lack of use. Physiologists agree that strength exercises are the best way of activating such fibers: as strength increases, they also increase in size and effectiveness. Sprinting is a strength exercise in the sense that it obviously requires more force, more strength of muscle than is needed to run slowly. From this it follows that sprinting practice not only improves the power to pass or to finish; it also increases the efficiency with which muscles work at slower speeds.

By way of rebuttal it is interesting to note that Stampfl places almost minimum emphasis upon speed training even though he is a strong advocate of interval training. In his training schedules for the mile, during an eight

months training program, he suggests only one workout at a pace that is faster than the four-minute mile on which he bases his figures. All workouts aim toward increasing stamina and, with a competitive season starting in May, he does not reach even racing speed (60 second quarters) until late April workouts. Stampfl may well be more right than wrong in this point of view, though it is interesting to note that his most famous protege, Bannister, found an occasional 15 x 150 yards a very satisfying and important part of his training program. Fortunately, there need be no serious argument for we do not need to choose between stamina and speed in our training. Rather, the viewpoint can be: having provided in the training program for maximum stamina through the use of pace-endurance work or long-interval work, we can also acquire maximum speed by means of speed-endurance and sprint work.

To review the training program as recommended thus far, it will be recalled that a full cross-country season was suggested, preferably one in which tension from competition is at a rather low level. Second, Fartlek or some form of repeated but unmeasured speed work is worthwhile as part of cross country training or as very early season track work. Third, with little or no lay-off after cross country, modified short-interval work should be started. This short-interval work is of two kinds: pace-endurance training and speed-endurance training. In pace-endurance work, the variable that increases as condition improves is the number of times a given distance is repeated. In speed-endurance work, the variable that increases as condition improves is the number of times a given distance is repeated. In speed-endurance work, the variable that improves with condition is the average speed at which a set number of runs can be made. Of these two types of workout, the writer believes that training at pace needs greatest emphasis and should comprise about sixty per cent of all workouts. Training for speed should compose about thirty per cent, with a final ten per cent reserved for long-interval work and time trials. As the season progresses, this relation will shift toward more speed-endurance and long-interval workouts.

Examples that have been used as illustrations have assumed a miler who hopes to run 4:16 by the end of this competitive season. A similar approach can be made for all other endurance runs. Space does not permit a detailed discussion for each distance, but Tables 1, 2, and 3 should provide a satisfactory explanation.

Table 1

Short-interval Pace-endurance Workouts

| Event | Meet time | Practice distance | Average speed | Number of repetitions | Jogging interval |
|---|---|---|---|---|---|
| 2-mile | 9:20 | mile | 4:40 | Two | A |
| | | 880 | 2:20 | | |
| | | 440 | :70 | (Increase | fixed |
| mile | 4:16 | 880 | 2:08 | as | |
| | | 440 | :64 | condition | time: |
| 880 | 1:56 | 440 | :57 | improves) | |
| | | 220 | :28 | | (5 min. |
| 440 | :50 | 220 | :24 | | or less) |

Table 2

Short-interval Speed-endurance Workouts

| | | | | | |
|---|---|---|---|---|---|
| 2-mile | 9:20 | 880 | | | |
| | | 440 | (Faster | Five | Fixed |
| | | 220 | as | " | time: |
| mile | 4:16 | 440 | | " | |
| | | 220 | condition | " | (3 min. |
| 880 | 1:56 | 220 | | " | or less) |
| 440 | :50 | 220 | improves) | " | |

Table 3

Long-interval training

| | | | | | |
|---|---|---|---|---|---|
| 2-mile | 9:20 | 1½ mile | 7:00 | Two, | At |
| | | mile | 4:30 | then | least |
| | | 880 | 2:02 | Three | 20 |
| mile | 4:16 | 3/4 | 3:12 | (As | minutes |
| | | 880 | 2:00 | condition | |
| 880 | 1:56 | 660 | 1:24 | improves) | |
| 440 | :50 | 330 | :36 | | |

As our understanding of interval training becomes clearer in detail and as our skill in its utilization improves, we believe physical potentials will be more and more realized. More importantly, we believe American distance runners, from high school to our greatest national champions can benefit through adoption of its methods and at the same time remain true amateurs and good students.