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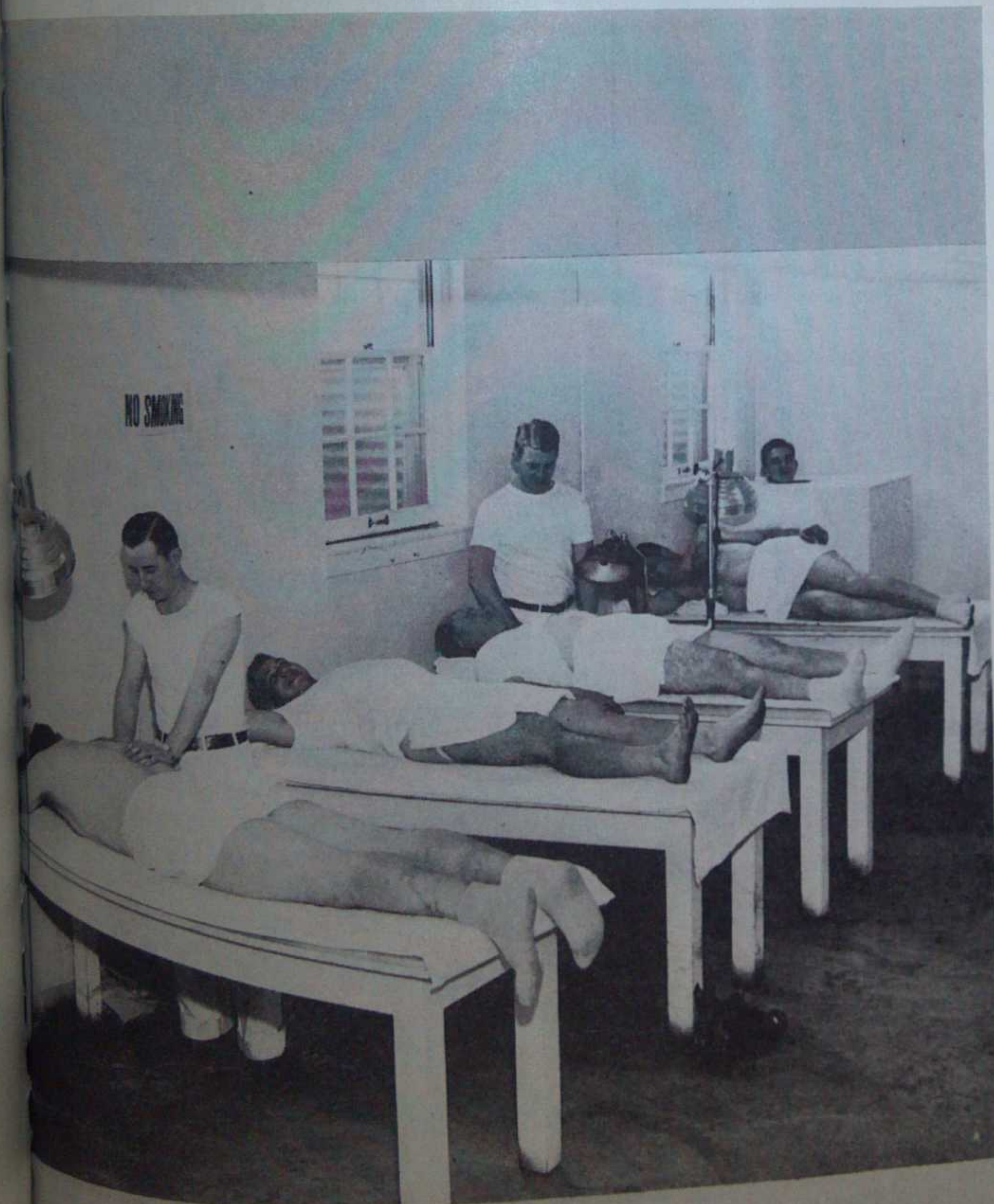
Official Publication
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Trainers Association

The Physiologic Effects of
Heat and Cold on
Muscle

W. W. Tuttle, Ph. D.

The College's Part in the
Army Training
Program

Phil Sarboe



Getting ready for football practice at the Great Lakes Naval Training Station. Standing in the rear, Head Trainer, Bob Peterson Sp. (A) 1/c, former assistant to Carl Ericson at Northwestern University. In the foreground Lou Reker, Sk. 2/c, assistant trainer.

An Announcement

It gives us a great deal of satisfaction to announce that Dr. Lloyd L. Boughton, Ph.D. is now with our firm.

Two years ago we retained Dr. Boughton as a consultant. At that time the "chemical world" was in chaos. Our sources of many basic crudes were lost. It was necessary that we go into the open market and bid for supplies. It was further necessary that these crudes be tested for purity and strength. For this job an expert was needed and as Dr. Boughton had been "drug analyst" for the State of Kansas for the past 16 years, we felt that he had the highest of qualifications.

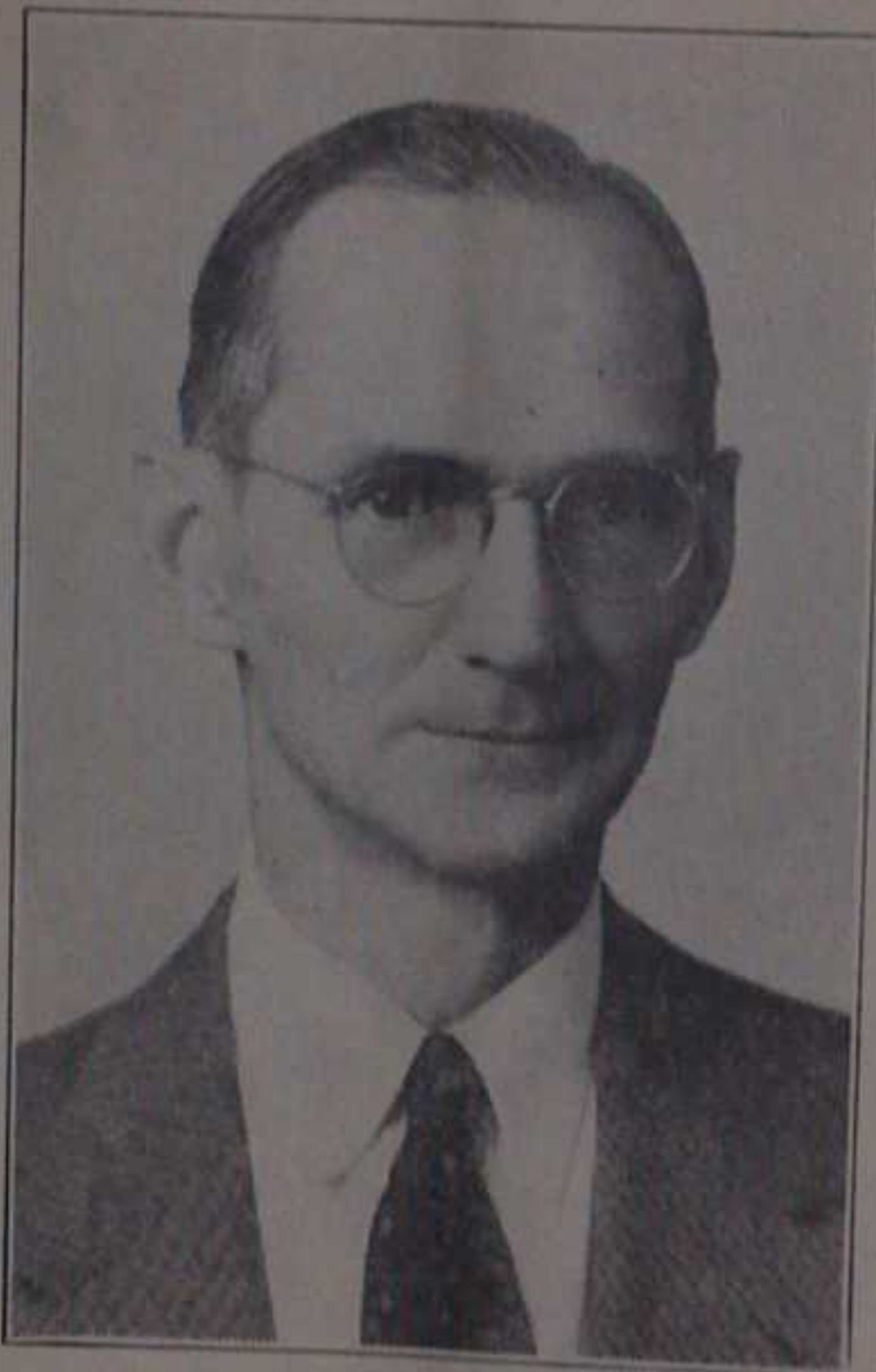
Now Dr. Boughton is with us in charge of research and promotion.

Born in South Dakota, in a dugout near Gettysburg, Dr. Boughton attended high school at Huron. He had two years at Huron College before World War I and completed his work at the University of Iowa after the war, attending the Iowa Coaching school under Howard Jones, Sam Barry and George Bresnahan in 1923. He came to Kansas in 1926 as a member of the School of Pharmacy faculty. Obtained his Master of Science degree in Biochemistry and Pharmacy, and his Doctor of Philosophy in Physiology and Pharmacology. He has been a member of the University of Kansas Medical School faculty for the last five years.

Dr. Boughton has carried on extensive research

in Pharmacy and Pharmacology, and has published many scientific articles in journals associated with those fields.

He has always been interested in athletics, won letters in football and track at Huron College. He served as first lieutenant, Infantry branch of the regular army during World War I, played football with Ossie Solem, Fred Becker and other well-known football notables at Fort Snelling, under Dr. Williams. Dr. Boughton served overseas with the Advance School Detachment of the 10th Division. He has been commander of two legion posts, at Platte, South Dakota, and at Lawrence, Kansas.



Dr. Lloyd L. Boughton, Ph.D., our Director of Research and Promotion.

In future issues of "The First Aider" you will find the results of his tests and findings in research. These articles will come to you as an "extra dividend" on your purchases of Cramer First Aid and Trainer's Supplies—a dividend toward safety and

greater efficiency!

When we ask you to purchase Cramer products, we hope to render a service which will justify continued support. We expect to prove our motto "He who serves—deserves", and make it a real, living thing.

The addition of Dr. Boughton to our staff is another step in this plan to serve you.

FRANK CRAMER, President

THE CRAMER CHEMICAL COMPANY

GARDNER

KANSAS

The Physiologic Effects of Heat and Cold on Muscle

By W. W. Tuttle, Ph.D.

Department of Physiology, University of Iowa

It is common experience among athletes that they perform better after an adequate period of warming up. Provisions are made also to avoid chilling both before and after strenuous exertion. The reason for this procedure is to permit maximum performance, to facilitate recovery, and to prevent injury. The use of heat and cold in the treatment of muscle injury of various types is a common practice.

Although it is well known that the physiologic activity of muscle is changed when muscle temperature is altered, the nature of the changes produced is not completely understood. This is especially true in the case of intact muscle. The problem has been complicated also, by the introduction of various methods of heating muscle.

Since the conventional way of cooling muscle is the application of ice, the effects of cooling muscle by this method have been investigated¹. The experimental procedure was to pack the gastrocnemius muscles of a group of individuals in ice, for various periods of time and then to compare the activity of the cooled muscles

THIS article is the second in a series to be presented by Dr. Tuttle in the Trainers Section.

muscle accordingly. The fact, that cooling is more effective in slowing relaxation than contraction, explains why antagonistic muscles are frequently injured, especially at the beginning of bouts of strenuous exercises, for example, sprinting. It is evident that to avoid such injury, the warm-up must be adequate to protect relaxing muscles against injury due to the strong, fast contraction of their antagonists.

It is of interest to compare the effects of warming muscles with those produced by cooling them. Although many methods are employed to heat muscle, the infra-red lamp and short-wave diathermy are usually preferred. Since both of these methods produce similar results, a statement of the effects of heat produced by short-wave diathermy, on the activity of intact muscle, will furnish the desired information.

In a recent experiment in our labora-

and before and after heating by the use of short-wave diathermy. A summary of the effects of heat on the intact muscle is shown in Table II.

The data reveal the fact that merely resting a muscle has no significant effect on the duration of contraction and relaxation. When the intact gastrocnemius muscle was heated, however, for twenty minutes by means of short-wave diathermy, the duration of both the periods of contraction and relaxation is significantly decreased. As in cooling, heating the muscle has a more pronounced effect on the period of relaxation. Heating the gastrocnemius muscle for twenty minutes by means of short-wave diathermy speeds its activity 19 per cent.

It was found, in a subsequent experiment, that where the infra-red lamp was used as a source of heat, the activity of the intact muscle was decreased, but to a much less extent than is the case with short-wave diathermy. Since the sensation of warmth produced by infra-red rays is much greater than by short-wave diathermy, it is evident that the infra-red lamp is effective for producing surface heat, but is not so well adapted to heating an intact muscle.

When the effects produced by cooling a muscle are compared with the effects brought about by heating, it is evident that an ice pack is much more effective in

TABLE I

	Contraction Time Sec.	Per Cent Increase	Relaxation Time Sec.	Per Cent Increase	Total Time Sec.	Per Cent Increase
Body temperature	0.089	..	0.267	..	0.356	..
5 min. cooling	0.108	21	0.432	62	0.540	51
10 min. cooling	0.130	46	0.574	115	0.704	98
20 min. cooling	0.162	82	0.726	172	0.888	150

TABLE II

	Before Sec.	Rest After Sec.	Per Cent Change	Before Sec.	Heat After Sec.	Per Cent Decrease
Contraction time	0.1020	0.1012	0.8	0.1009	0.0893	12
Relaxation time	0.2464	0.2546	3.3	0.2543	0.1976	22
Total time	0.3484	0.3558	2.1	0.3552	0.2869	19*

with their activity at body temperature. Some of the results are shown in Table I. The data in the accompanying table show that cooling for a period as short as five minutes increased the time required for all phases of muscle activity, and that the longer the cold is applied the greater this increase becomes. Cooling the intact gastrocnemius muscle for five minutes increases the total time involved in the contraction process by 50 per cent; cooling it for 10 minutes doubles the time, and cooling it twenty minutes is responsible for a three-fold increase in time. The data also show, that although the contraction time is materially slowed, it is the relaxation time of the muscle which suffers most when the muscle is cooled. This evidence, in the hands of the trainer, makes him better able to appreciate the effects of cold on muscle, so that he may limit the activity of the

tory, heat produced by short-wave diathermy was applied to the intact gastrocnemius muscles of twenty individuals selected at random, and the effect of the heat on the activity of these muscles was studied. Since the dosage of heat employed was twenty minutes in duration, it occurred to us that twenty minutes of rest might be the factor responsible for changes in the activity of the muscle. To avoid confusing any effects which rest might have with those produced by heat, a control experiment, involving rest alone, was included.

The experiment, similar to the one on cooling, involved measuring the duration of the periods of activity of the intact gastrocnemius muscle before and after rest,

slowing its activity than heat is in accelerating it. The reason for this difference is that the muscle temperature is decreased materially more by the ice pack than the temperature is increased by the short-wave diathermy. In fact the muscle temperature may be lowered as much as twenty degrees centigrade by ice, while short-wave diathermy raises the temperature no more than five degrees.

The pronounced effects brought about by changing the temperature of a muscle necessitate familiarity with the facts on the part of the trainer, if he is to get the most out of the use of heat and cold. Such information may prove helpful, also, in preventing injury caused by the overuse of a cold muscle.

¹Tuttle, W. W. The Effects of Decreased Temperature on the Activity of Intact Muscle. J. Lab. and Clin. Med. 26:1913-1915, 1941.

The College's Part in the Army Training Program

By Phil Sarboe

Coach of Football and Track and Athletic Trainer Washington Central College, Ellensburg

THROUGHOUT the country the United States Army has set up college training detachments, to better prepare aviation cadets for flight training, in an increased effort to prosecute the war and bring it to a quicker end, and throughout the Army are thousands of young men eagerly waiting the call to join other students at these detachments.

A rigorous, well-planned training course, both mental and physical, is in operation at each one of these schools.

Immediately upon arriving at the detachment, each student begins a transition from an enlisted man to cadet. Within two short weeks after his arrival, it would be impossible to identify him as the soldier who had arrived such a short time before. There is a firmness to his walk that was not present before, a new set of shoulders. He has already begun to act and think as a United States cadet of the model Army Air Forces.

The aviation student's program calls for 424 hours' academic subjects; 200 hours' supervised study; 126 hours' military training; flying and connected subjects for 48 hours; 35 hours' detachment Commanding Officer and physical training for 120 hours.

The last mentioned part of the program—the physical training—is the one commanding our attention for the present and the one upon which I shall write.

The physical training program at these detachments is always a workable one, designed to give the aviation student endurance, stamina, co-ordination and general physical efficiency. When a student finishes this training, it may be truly said that he is the world's finest fighting man.

Central Washington College, Ellensburg, Washington, was chosen as one of the training detachments of the United States Army Air Forces, largely through the efforts of Dr. R. E. McConnell, college president, who is vitally interested in his school serving to the greatest advantage in the war effort.

Leo Nicholson, athletic director at the college for the past twelve years, is at the head of the physical training program. "Nick" spent two weeks at the West Coast Training Center, going through the indoctrination program for college directors and came back fired with the determination to make things click at C. W. C. There is no doubt that he has succeeded in getting things humming around the "sweat plant." Everybody has caught the spirit of the air corps, the desire on the part of the indi-

vidual to improve himself physically.

The ultimate aim of the calisthenic program is to develop an all-around, thoroughly co-ordinated and well-toned musculature. When the body has been made supple, stiffness in the joints eliminated, shortened muscles stretched, so that as all parts of the body function effectively, a well-trained individual results. Without question, the man who has received such training can handle his body more skillfully as a soldier than those not so trained.

Calisthenics are for all parts of the body. All are employed in each lesson for the harmonious development of the entire body. They serve not only to develop all parts of the body, but also as a warm-up to prepare the trainee for the more strenuous exercises which immediately follow.

Considerable educational and disciplinary value is the net result when the exercises are properly executed. To accomplish this goal, much emphasis must be placed on preciseness of movement and strict adherence to commands.

The men should be conditioned gradually to the calisthenics. This can be done by taking time to give careful explanations and to insist upon perfection in performance the first week. If the trainees are introduced to the exercises too rapidly they are likely to develop an antagonistic attitude toward them. In addition, they tend to develop a habit of performing movements improperly because of bodily stiffness and soreness. In wet weather and on damp ground, exercises using the prone and supine positions should be omitted. The length of each exercise should be adjusted to the condition of the men.

The exercises that follow differ from those now in general practice, in that they are more strenuous and varied in nature. They are presented for the purpose of placing greater emphasis on the physical conditioning of troops, of developing greater agility and co-ordination and of stimulating interest in this important type of training. Physical training directors are reminded that all physical conditioning must be progressive, systematic and carefully supervised. Serious injury may result if unreasonable physical demands are made of unconditioned individuals who, for any reason, are below the physical standard of the average.

Trainees should be required to learn the drills "by heart." There are three advantages in this: 1. It facilitates the conduct of the program. 2. It is more pleasing and more beneficial to the trainees. 3. The

trainees will know a good set of exercises which they can perform on their own. Learning the exercises can be expedited in several ways such as conducting an intersquadron competition, staging a demonstration for the Commanding Officer, or visiting officials, or demonstrating one exercise and then letting the men practice independently.

Considerable use is made of mass commands in conducting these exercises to assist in overcoming individual diffidence and timidity and in developing confidence, assertiveness and enthusiasm.

These exercises are in three different sets of drills, ten exercises to each drill.

Calisthenic Drill 1

1. HIGH JUMPER (4 counts in series). *Starting Position:* Feet separated 12 inches, knees slightly bent, arms raised backwards. *Exercise:* 1. Swing arms forward and jump upward. 2. Swing arms backward and jump upward. 3. Swing arms forward, upward and jump upward at least one foot. 4. Swing arms backward and jump upward.

2. BENDING GROANER (4 counts in series). *Starting Position:* Feet apart sideward 24 inches, arms sideward, palms upward. *Exercise:* 1. Bend trunk forward and down, swinging arms between the legs, bending knees and touching ground about 12 inches behind the heels; exhaling and groaning on this movement. 2. Recover to starting position, wailing with audible gasp. 3. Same as 1. 4. Same as 2, etc.

3. HIP BOUNCE (4 counts in series). *Starting Position:* Squat on left leg, right leg extended backward, toe on ground, hands on ground at shoulder width and 4 inches forward of left foot. *Exercise:* 1. Change feet. (Land with a bounce.) 2. Bounce hips. (Keep feet on ground.) 3. Change feet. (Land with a bounce.) 4. Bounce hips. (Keep feet on ground.)

4. TRUNK TWISTER (4 counts in series). *Starting Position:* Standing with feet apart sideward 24 inches, hands clasped behind head, elbows held backward hard, chin held in. *Exercise:* 1. Bend forward, knees straight. Do this vigorously. 2. Bounce downward, but simultaneously rotate trunk sharply to left. 3. Same, but to right. 4. Return to original position, pulling head back and chin in strongly.

5. KNEE BEND (4 counts in series). Feet apart sideward 4 inches, hands on hips. The exercise is done in two parts. *Exercise A:* 1. Half knee bend, arms for-

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Calisthenic Drill 1

BUMPER (4 counts in series).
Starting Position: Feet separated 12
slightly bent, arms raised
Exercise: 1. Swing arms for-
upward. 2. Swing arms
jump upward. 3. Swing
upward and jump upward
ot. 4. Swing arms backward
ward.

ING GROANER (4 counts in
Starting Position: Feet apart side-
s, arms sideward, palms up-
e: 1. Bend trunk forward
aging arms between the legs,
and touching ground about
and the heels; exhaling and
is movement. 2. Recover to
on, wailing with audible
as 1. 4. Same as 2, etc.

ANCE (4 counts in series).
Starting Position: Squat on left leg, right
backward, toe on ground,
and at shoulder width and 4
of left foot. Exercise: 1.
Land with a bounce. 2.
Keep feet on ground. 3.
(Land with a bounce. 4.
Keep feet on ground.)

TWISTER (4 counts in se-
Starting Position: Standing with
eward 24 inches, hands
head, elbows held backward
in. Exercise: 1. Bend for-
ward, but simultaneously
urply to left. 3. Same, but
return to original position.
k and chin in strongly.
END (4 counts in series).
ward 4 inches, hands on
ise is done in two parts.
Half knee bend, arms for-

ward. 2. Recover to the starting position.
3. Same as 1. 4. Same as 2. Exercise B:
Follow the same movements with the ex-
ception of assuming the full knee bend
position on "one" and "three."

6. MODIFIED BURPEE. *Starting Po-
sition:* Attention. Exercise: 1. Squatting
position (hands on ground in front of feet;
Shoulder width apart). 2. Recover or ex-
tend the legs rearward to the front leaning
rest position. 3. Recover to the squatting
position. 4. Recover to the starting posi-
tion.

7. ROWING EXERCISE. *Starting Po-
sition:* Supine, arms extended overhead,
legs straight. Exercise: 1. Sit up, and at
the same time bend knees sharply. Lean
forward, thrusting or swinging arms for-
ward to a rowing position with knees
against chest, and arms forward. 2. Return
to starting position. 3. Same as 1. 4. Same
as 2.

8. PUSH UP. *Starting Position:* Front
leaning rest. Exercise: 1. Bend elbows and
touch chest to ground, keeping body
straight. 2. Straighten elbows, returning
to front leaning rest. 3. Same as 1. 4.
Same as 2.

9. BANK TWIST. *Starting Position:*
Supine, arms extended sideward, legs
raised straight up with feet together. Ex-
ercise: 1. Swing legs vigorously to left,
touching ground, on left side. 2. Same to
right. 3. Same to left or 1. 4. Same as 2.

10. SQUAT JUMP. *Starting Position:*
Full knee bend with left foot forward
about 8 inches sitting on the rear heel.
Hands clasped on top of head. Exercise:
1. Bounce from this squat, and spring up-
ward until knees are straight and both feet
have left the ground, and change position
of feet, the rear foot becoming the forward
foot and vice versa drop to squat and sit
on rear heel again. 2. Same as 1. 3. Same
as 1. 4. Same as 1, etc.

Calisthenic Drill 2

1. SIDE STRADDLE HOP. *Starting
Position:* Attention. Exercise: 1. Hands
on hips, legs astride. 2. Recover. 3. Arms
overhead, palms together, legs astride. 4.
Recover.

2. ROTATING THE ARMS AND
SHOULDERS. *Starting Position:* Arms
sideward, palms upward, feet together.
Exercise: 1. Rotate the arms and shoul-
ders in 12"-18" backward circle. 2. Repeat
one. 3. Repeat one. 4. Repeat one.

3. TRUNK BOUNCE. *Starting Posi-
tion:* Hands on hips, legs astride (12" to
18"). Exercise: 1. Bend trunk forward
and downward. Touch the ground to the
left of the left foot in a bouncing move-
ment. 2. Touch the ground in between the
feet in the same bouncing movement. 3.
Touch the ground to the right of the right
foot in the bouncing movement. 4. Re-
cover.

4. LEG STRETCH. *Starting Position:*
Squatting Position. Exercise: 1. Extend
both legs laterally to the side-straddle po-

sition, keeping the hand on the ground.
2. Recover. 3. Extend both legs rearward
to the front leaning rest position. 4. Re-
cover.

5. CO-ORDINATED LUNGE. *Start-
ing Position:* Hands on Hips. Exercise:
1. Lunge obliquely to the left, raising the
arms sideward, palms upwards. 2. Bend
trunk downward and encircle the left thigh
with both arms, placing the chest on the
thigh. 3. Recover to the 1 position. 4. Re-
cover. 5. Five, 6, and 7 are the same
movements as described in 1, 2 and 3, only
done to the right.

6. BURPEE PUSH-UP. *Starting Po-
sition:* Attention. Exercise: 1. Squatting
position. 2. Extend legs rearward to the
front-leaning rest. 3. Bend elbows and
touch chest to the ground, keeping the
body straight. 4. Recover to the front
leaning rest. 5. Recover to the squatting
position. 6. Recover to the starting posi-
tion.

7. BODY LIFT. *Starting Position:* Su-
pine with finger laced behind the neck—
legs apart approx. 18". Exercise: 1. Raise
the trunk and bend forward and down-
ward touching the left knee with the right
elbow. 2. Recover to the starting posi-
tion. 3. Raise the trunk forward and
downward touching the right knee with
the left elbow. 4. Return to the starting
position.

8. CROSS OVER. *Starting Position:*
Supine, arms sideward, palms downward,
legs together. Exercise: 1. Raise the left
leg to the right touching the right hand
with the left foot. 2. Recover. 3. Raise
the right leg to the left touching the left
hand with the right foot. 4. Recover.

9. RAISING THE HIPS. *Starting Po-
sition:* Sitting position of attention (sit-
ting with hands flat on the ground behind
the hips, legs and feet together). Exer-
cise: 1. Draw the knees to the chest, feet
flat on the ground. 2. Recover. 3. Raise
the legs swinging them over the head and
touching the toes to the ground overhead.
4. Slowly recover to starting position.

10. ROCKING CHAIR. *Starting Posi-
tion:* Supine position, arms extended over-
head, feet spread approximately eighteen
to twenty-four inches. Exercise: 1. Raise
the upper trunk, thrusting arms forward,
touching the toes, keeping the knees
straight. 2. Recover. 3. Raise the legs
swinging them over the head and touch-
ing the toes to the ground overhead. 4.
Slowly recover to starting position.

Calisthenic Drill 3

1. THE STEPPER. *Starting Position:*
Hands on hips. Exercise: 1. Jump to for-
ward hop-straddle, left foot forward, right
foot back, feet 18 inches apart. 2. Re-
cover to starting position. 3. Jump to
forward hop-straddle, right foot forward,
left foot back. 4. Recover to starting po-
sition. 5. Jump to one-half side-straddle,
feet twenty-four inches apart, raising arms
overhead as in side-straddle hop. 6. Re-

cover to starting position. 7. Jump to full
side-straddle, raising arms overhead. 8.
Recover to starting position.

2. THE ARM RAISER. *Starting Po-
sition:* Attention. Exercise: 1. Arms raised
forward. 2. Arms sideward. 3. Arms for-
ward. 4. Arms overhead. 5. Arms for-
ward. 6. Arms sideward. 7. Arms for-
ward. 8. Arms down (to starting posi-
tion).

3. TRUNK BEND. *Starting Position:*
Standing, legs astride twelve inches, arms
at thrust. Exercise: 1. Bend to the squat-
ting position (bouncing movement, reach
fingers to ground). 2. Return to starting
position. 3. Bend trunk forward, knees
straight, reaching fingers to ground. 4.
Return to starting position.

4. TWISTING TOE TOUCHER.
Starting Position: Legs astride twenty-
four inches, arms sideward, palms up. Ex-
ercise: 1. Rotate trunk left and bend for-
ward, touch right hand to outside of left
toe, extend left hand upward (a bouncing
movement). 2. Return to starting posi-
tion, arms execute a slight backward
bounce. 3. Rotate trunk right and bend
forward, touch left hand to outside of
right toe extend right hand upward (a
bouncing movement). 4. Return to start-
ing position, arms execute a slight back-
ward bounce.

5. LOOKING FOR THE ENEMY.
Starting Position: Back elbow support po-
sition (sitting, legs extend weight resting
on elbows, head hanging loosely back-
ward). NOTE: On wet grounds, these
exercises may be executed from the stand-
ing position, hands on hips.

Exercise A: 1. Turn head as far as pos-
sible to the left, look backward over left
shoulder. 2. Recover. 3. Turn head as
far as possible to right, look backward
over right shoulder. 4. Recover.

Exercise B: 1. Bend head forward as
far as possible and look downward. 2. Re-
cover. 3. Same as one, looking backward.
4. Recover.

Exercise C: 1. Roll neck from left to
right in complete circle in four slow counts
(pushing chin against left shoulder, back
of head into back of shoulders, chin into
chest, etc.). 2. Repeat 1. 3. Same as 1
only in opposite direction—right to left.
4. Repeat 3.

6. TRUNK RAISER. *Starting Posi-
tion:* Supine, feet together, arms extended
overhead. Exercise: 1. Sit up and bend
trunk forward, touch both hands to toes
(the forward reach is a bouncing move-
ment). 2. Raise trunk to a sitting posi-
tion (chest up, head up), raise arms over
head. 3. Return to 1 (a bouncing move-
ment). 4. Return to starting position.

7. TWIST AND STRETCH. *Starting
Position:* Sitting, feet approximately
thirty inches apart, arms at horizontal
flex. Exercise: 1. Touch right hand to
left toe. 2. Recover to starting position.
3. Touch left hand to right toe. 4. Recover.
(To be concluded in December)